PHILOSOPHICAL TRANSACTIONS.

I. *Researches on the Structure, Organization, and Classification of the Fossil Reptilia.*—Part IX., Section 4. *On the Gomphodontia.*

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Received and Read June 21, 1894.—Revised November, 1894.

[Plates 1, 2.]

Introduction.

The Gomphodontia comprises animals with a Theriodont type of dentition, in which the molar teeth are expanded transversely, and have more or less tuberculate crowns, of the type shown in *Diademodon*. The superior and inferior teeth are opposed to each other, and the crowns become worn with use, as in Ungulate and other Mammals, and as in Iguanodont Reptiles. The canine teeth of the upper jaw appear to be worn at their extremities.

The skull is known from the genera *Gomphognathus*, *Trirachodon*, and *Microgomphodon*. It appears to show mammalian proportions and aspect, in the definition of the large temporal vacuities by a zygomatic arch, which is formed by the malar and squamosal bones, and in the separation of those vacuities from each other by a long narrow parietal crest. The orbit of the eye, however, is separated from the zygomatic vacuity by a post-frontal bone, so that the structure is distinct from that which obtains in Ungulates, Lemurs, and all Mammals in which the orbit is similarly complete.

There are two well-defined occipital condyles at the back of the base of the skull, united to each other inferiorly in a way that is closely paralleled in some Mammals. Each condyle is transversely wide, and convex, and together they form a curve, which differs from most Mammals in the smallness of the median vertical notch between them, which is scarcely so much developed as in certain Cetacea.

The occipital plate of the skull has a triangular form, and is more or less concave, as in many Mammals, without any conspicuous perforation, except the foramen magnum. It appears to be formed substantially on the plan of the occipital plate in *Dicynodon*. The absence of a large lateral foramen distinguishes it from the occipital

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plate in *Cynognathus* and the carnivorous Cynodontia, with which these animals have many resemblances in skull structure. Externally, at the sides of the occipital plate, there is a deep superior notch, which defines the back of the skull from the lateral external squamosal bar of bone, which extends along the upper part of the zygoma. The malar bone, which extends behind the orbit and unites with the squamosal bone to form the larger part of the zygoma, develops a small descending process on its inferior margin, which varies in size, and is found immediately behind the orbit, as in some Mammals.

The hard palate formed of the maxillary and palatine plates terminates transversely in the middle length of the molar teeth, in a way which is remarkably like the dental condition of certain marsupial Mammals. Behind the palato-nares there is a transverse descending palatine arch, into which the transverse bones appear to enter, which is situate behind the orbits, and extends downward, so that its external edges abut against the rami of the mandibles, as in Crocodiles, Rhynchocephalia, and some Lizards. Hence this arch attains a development which is unknown in the Mammalia.

The incisor teeth are small and pointed, and do not show the conspicuous depth which is seen in some placental Mammals, rather resembling Marsupials.

The canine teeth may be inconspicuous, as in *Microgomphodon*, and practically indistinguishable from the incisors; but they are usually large, compressed, and have serrated margins. The pre-molar teeth are small and circular, usually tuberculate, but occasionally the first tooth is compressed from side to side in a way that characterizes Marsupials, and it is then longer than wide. The molar teeth are usually single rooted, arranged in close set series, which diverge outward as they extend backward. The crowns commonly increase in transverse width to the middle of the series; the grinding surfaces vary in form and character, but usually have the internal and external cusps more prominent than the other tubercles of the crown, making an approximation to the form of the crown in the Lizard *Teius*.*

In all known examples the rami of the lower jaw are blended at the symphysis, are formed externally by the dentary bones, which develop an inferior posterior angle, as in many Mammals, and the dentary bone has a high coronoid process. The articulation of the mandible with the squamosal region of the skull is made by elongated articular bones, which extend loosely on the inner side of the dentary element, which is not known to enter into the articulation in any specimen, though it adjoins the articular margin. The quadrate bone appears to be reduced to a small ossicle, embedded in the squamosal bone, but exposed on its posterior aspect, behind the articular condyle for the lower jaw, into which it appears to enter. These characters are common to the Cynodontia.

So far as is known, there is no fundamental difference in the skeleton to separate the Gomphodontia from the Cynodontia, which may be regarded as related in the same way as are groups of Marsupials with similarly differing dentition.

* 'Roy. Soc. Proc.,' vol. 44, p. 139.

In the lower dorsal region, in both groups, provided the skeleton presently to be described is rightly referred to the genus *Microgomphodon*, there is a similar transverse expansion of the ribs into lozenge-shaped or triangular extremities, so as to form an interlocking union, similar to that of the zygapophyses on the neural arch. In so far as can be judged from the imperfect means for comparison, there is no fundamental difference in the construction of the pelvis, unless it be in the exclusion of the pubic bone in Gomphodontia from the acetabulum for the femur, since it appears to articulate to a small tubercle on the ilium ; whereas in the Cynodontia the pubis takes its normal part in forming the acetabulum. In the femur the long lateral trochanter, which resembles that of Megalosaurs, is much less developed than in the Cynodontia. In the tarsus the astragalus and calcaneum are both comparatively large bones, but there is no development of the heel of the bone in the latter ossification. The scapula has the acromion reflected upward and continued up the bone as its spine, and the bone is constructed on the same plan as in *Cynognathus*. The interclavicle is thin, wide, and long. The humerus does not differ in plan from other Theriodonts. All the bones show characters which indicate approximations to the Saurischia, and Mammalia, of the same kind as those which the Ornithischia show to birds in the same parts of the skeleton. They do not obliterate the interval between the Mammalia and the Reptilia ; but a closer relationship between those groups than was previously evident, appears to be shown in the structure of these new animals. If the mammalian characters are obvious from comparison with existing types, the reptilian characters can only become fully evident when the skeleton of the Dicynodont reptiles is described.

The further evidence of the structure of the Gomphodontia is now submitted in a description of the remains of the three new genera, which have already been referred to. The South African genera appear to include :—

Tritylodon.
Diademodon,
Gomphognathus.
Trirachodon.
Microgomphodon.

I. Gomphognathus.

This genus is founded upon skulls of which two were collected by myself at Lady Frere, and two collected by Dr. D. Kannemeyer, near Burghersdorp. The distinctive features are, first, (1) There are two well-defined occipital condyles united at the base; (2) The occipital plate is triangular as in a Mammal; (3) A deep V-shaped notch separates the external squamosal bar from the occipital plate ; (4) The posterior surface of the squamosal bone is deeply excavated by an inverted

V-shaped channel; (5) The malar bone extends backwards as far as the occipital condyle, descending in a sickle-like curve; (6) There is also behind the orbit a conspicuous descending process to the malar, much more developed than in *Cynognathus;* (7) The teeth are on the usual Theriodont type, with small circular pre-molars and molars, which are transversely ovate, in the middle region. The teeth are worn down with use. A prominent external cusp hides the flattened grinding surface which is internal to it. The teeth are densely packed in close contact with each other as in a Mammal; (8) The quadrate bone appears to contribute with the squamosal to form the articulation for the lower jaw; (9) As in other Theriodonts of this group the nares are terminal in front and divided by the nasal and pre-maxillary bones; (10) The orbits of the eyes are relatively small, slightly ovate, and in the middle length of the skull, separated by the post-frontal bones from the large superior temporal vacuities, which are separated from each other by the parietal crest; (11) The lower jaw is composite; (12) The palate bones are developed downward between the rami of the mandible in an arch, which is behind the orbits.

Specimens from Burghersdorp.

I am indebted to the Trustees of the Albany Museum for the opportunity of studying a specimen which had been discovered near Burghersdorp and partly developed from the rock by Dr. KANNEMEYER, who presented it to them. It has been further developed under my direction, and shows the characteristic structure of the post-orbital region of the skull, and of the lower jaw. I have purposely made this specimen the type of the genus, because I have reason to hope that Dr. KANNEMEYER may be able to supply evidence hereafter of other parts of this skeleton.

Gomphognathus Kannemeyeri.—Lower Jaw. (Figs. 1 and 2.)

No symphysial suture can be traced between the rami of the mandible. The two halves of the jaw diverge backward. They approximate rather more on the alveolar, than on the basal margins. The jaw is $6\frac{1}{4}$ inches long; $1\frac{8}{10}$ inch from the angle to the articulation. The coronoid process is well developed upward and backward.

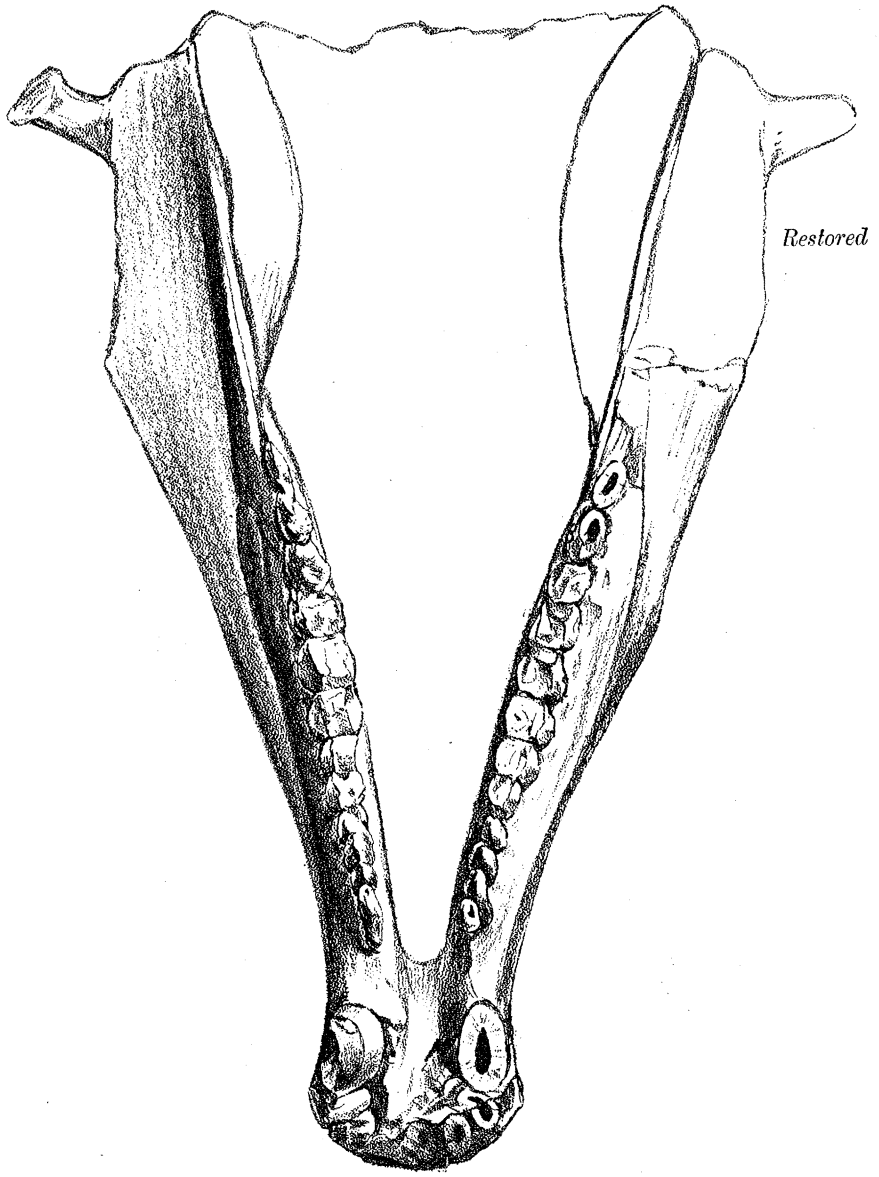
The jaw is $1\frac{8}{10}$ inch deep at the articulation, rather deeper at the angle, $1\frac{9}{10}$ inch behind the last molar, and $\frac{8}{10}$ inch deep at the diastema in front of the first pre-molar tooth.

The symphysial region is a little over an inch wide at the alveolar border in front, and contracts towards the base about $\frac{3}{20}$ inch, as it recedes backward and downward and merges in the rounded margins of the compressed diverging rami.

This area is convex from above downward and also from side to side. A slight angle descends from the anterior margin of the canine towards the bifurcation of the rami at the base, which separates the nearly vertical external side of the jaw from the antero-inferior symphysial area. The length of the dentary element from

the bifurcation to the inferior angle is about $3\frac{1}{2}$ inches. The thickness of the jaw augments from $\frac{2}{10}$ inch at a little behind the symphysis, to upwards of $\frac{4}{10}$ inch at the angle. At this point the transverse internal measurement is $2\frac{6}{10}$ inches.

Fig. 1.



Mandible of *Gomphognathus Kannemeyeri*, showing the dentition and the external position of the articulation on the articular bone. Nat. size.

The vertical external surface of the jaw is notched superiorly by the diastema, which is short. The surface is a little convex from above downward; but the coronoid process being reflected inward above the articular bone, a broad shallow channel is formed on the upper hinder half of the dentary bone, which is prolonged forward and downward as a narrow depression along the middle of the ramus for about two-thirds

the length which is occupied by the molar teeth. The lateral contours of the dentary bone are similar to those of other Theriodonts. The basal contour is almost straight to the angle, where the bone recedes at about 45° upward and backward, forming a sharp posterior edge, which is nearly straight, and rests superiorly upon the articular bone, so as to expose the articular condyle in a position which is external to the dentary bone not seen in other specimens. Above the articulation the posterior truncation of the coronoid process of the dentary bone appears to be vertical. The coronoid process is compressed to a knife-like thinness, and its superior border behind the teeth is slightly convex in anterior contour, just as the alveolar margin is slightly concave. The coronoid region may be regarded as prolonged forward by the inflation of the bone below the teeth, which gives a slight convexity to the upper half of the external side of the jaw.

The incisor teeth are arranged transversely in a slight crescentic curve. All have lost their crowns, they are six in number, equal to three in each ramus. The transverse measurement over the third pair is $\frac{19}{20}$ inch. The teeth appear to be transversely ovate; they may decrease slightly in size from the first to the third. Immediately behind the incisors are the longitudinally ovate canine teeth $\frac{9}{20}$ inch long, and $\frac{5}{20}$ inch wide. The crown now broken away, appears to be compressed posteriorly, and directed a little outward as well as upward. The canine teeth are separated from each other by a deep channel which is the beginning of the division between the rami. The crowns are large and longitudinally ovate. Immediately behind the canines is the diastema, rather less than $\frac{4}{10}$ inch long, with a slight sharp median ridge. To this succeeds the molar teeth which occupy a length of $2\frac{13}{20}$ inches. They are 13 in number on each side of the jaw.

The first three or four are conical, with the crowns enamelled, slightly expanded posteriorly at the base of the enamel, so as to form a posterior cusp, and there is also a slight anterior cusp. The principal cusp is serrated on the posterior border; but although the anterior margin is compressed and rugose, the serrations appear to take the form of beads, which are broken away. The external surface of the crown is convex; but the internal surface is concave from above downward, owing to the transverse thickening due to the development of a cusp at the base of the crown on the inner side. This internal heel I regard as the most distinctive character of the teeth in this genus, coupled with the slight indication of the posterior cusp on the external surface. Few of my specimens, however, show the internal aspect of the teeth; and evidence will hereafter be given that a tooth of not dissimilar type, though wanting the lateral cusp, and having the crown more elevated, characterizes *Tapinocephalus*. The five succeeding teeth are badly preserved in both rami, and have lost the summit of the crown, but whether this is entirely due to breakage or partly the result of wear is not evident, though there are some indications that the teeth are worn, especially in the condition of the eighth and ninth on the right side. The last four on the right side show indications of the crown. It is convex

in front with a distinct heel, which occupies the inner side and hinder border of the tooth, and appears to terminate in an elevated margin, formed of a series of small cusps which succeed each other like a row of beads. The crowns which are worn down are transversely ovate, but these hindermost crowns, especially the last four, are longitudinally ovate. With the narrower breadth of the tooth the inner cusp becomes less developed. The last tooth is represented by a crown without visible cusps; it is compressed from side to side, so as to form a sharp superior edge. All the teeth are densely packed together. In front they are inclined a little backward, and overlap each other obliquely. These teeth present a distinct generic type, and are remarkable for the changes of form which they undergo, owing to the transverse widening in the middle of the series, which results from the development of the internal cusp. The internal alveolar border appears to be lower than the external border. The first four teeth may be counted as pre-molars on account of their small size and slight development of the inner cusp.

One of the most remarkable characters of the jaw is the inward reflection of the coronoid process so as to expose the articulation as a transversely ovate facet external to the dentary bone. This facet is half an inch wide, convex from front to back, concave from side to side, and seen from above presents an extraordinary appearance in its transverse development, which is slightly backward and slightly downward. But seen from the side it is manifestly the transverse development of the articular bone which is $\frac{13}{20}$ inch deep behind, has a straight base, and is prolonged backward from behind the middle depth of the dentary bone at about $\frac{7}{10}$ inch above the angle of the jaw. The surface of the articular bone narrows rapidly as it extends forward as a flattened plate hidden behind the inner side of the dentary bone.

As preserved the lower jaw is open at about an angle of 90° with the palate. The back of the skull is preserved in natural position, but the connection between skull and mandible is only seen on the right side, owing to the removal and loss of the coronoid articular and adjacent bones on the left side.

The back of the skull, which is imperfectly developed, appears to be nearly an equilateral triangle, with the sides converging upward so as to form lateral halves to the occipital crest, from which the parietal crest is given off at right angles without any appearance of posterior bifurcation. Owing to this form the back of the head is more Mammalian in aspect than in other genera, and the squamosal bone does not appear to ascend towards the parietal crest. The parietal bone is defined in the usual way by an inferior lateral groove which ascends as it extends forward along the inner border of the temporal vacuity. It is indicated on the right side. The external bar of the squamosal bone ascends convexly from the hinder border of the brain case, so as to define the outer boundary of the oblique, transversely ovate temporal vacuity, which is bounded in front by the post-frontal bone and by the malar bone. The post-frontal bone which forms the back of the orbit appears to be developed at a level above the parietal crest, but this may be due to the summit of the crest being

broken away. The length of the parietal crest, as preserved, is $1\frac{8}{10}$ inch, and the width of the temporal vacuity posteriorly, from the crest to the squamosal, is about 2 inches. Perhaps the most remarkable feature in the skull is the way in which the squamosal bar is compressed as it extends posteriorly for a depth of about $\frac{4}{10}$ inch. The matrix is not entirely removed, so as to show whether this excavation is merely a deep groove in the squamosal bone, or whether it defines another bone external to the squamosal, which lies between it and the malar. The evidence points to the

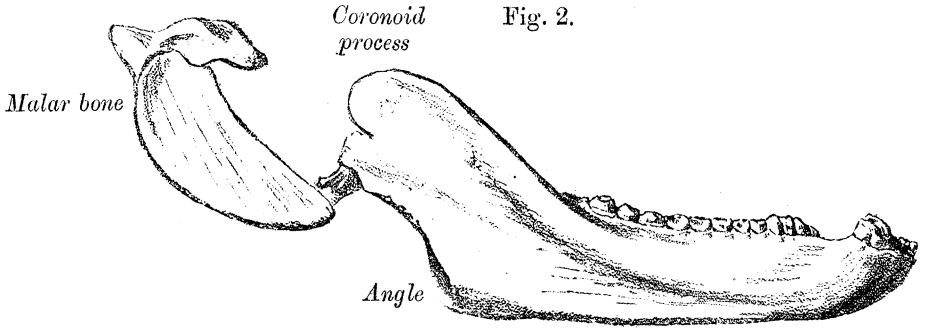


Fig. 2.

Gomphognathus Kannemeyeri. External aspect of the mandible articulated with the skull. The post-orbital part of the malar bone is shown. The axis of the palate is at an angle of ninety degrees with the mandible. $\frac{1}{2}$ nat. size.

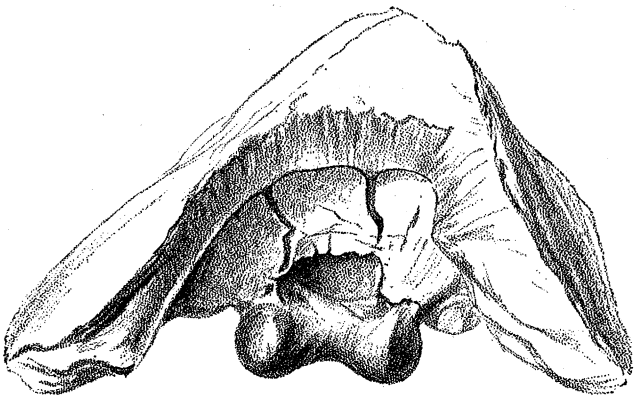
conclusion that the posterior surface of bone, which is convex from above downward, and extends transversely outward for a width of an inch, external to the inner ascending bar of the squamosal, with which it is obviously in contact, is the buttress of the squamosal which gives attachment to the lower jaw and forms the larger part of the condylar surface for the articular bone. There appears to be a small triangle of bone defined by a suture between this buttress and the inner bar of the squamosal which makes the outer border of the temporal fossa, and, since that surface is manifestly in contact with the inner half of the condyle of the lower jaw, I am disposed to regard it as indicating the quadrate bone.

Another remarkable feature of this skull is seen in the mode of development of the malar bone. Below and behind the orbit a process is developed downward and backward (fig. 2), which is also extended outward, rounded at the base, concave in front, compressed behind; it is half-an-inch wide, and separated from the part of the malar bone behind by a deep notch. The hinder part of the malar bone is flattened, vertical, lunate, convex above and slightly concave below. It is directed backward, downward and outward, terminating at the articular condyle, and so developed that a narrow strip of the squamosal bone is seen behind it. This sickle-shaped downward development of the malar, posteriorly, and the development of the sub-orbital teat-shaped process, are characters which distinguish this genus from all others, though *Cynognathus* makes some near approximation. The hinder part of the palate shows that the sphenoidal region was compressed in the usual way to a sharp keel, at the sides of which the lateral ridges were developed which were presumably formed by

the pterygoid bones. I estimate the width of the back of the skull, external to the articulation, to have been 5 inches; and that the skull extended about half-an-inch behind its articular condyle.

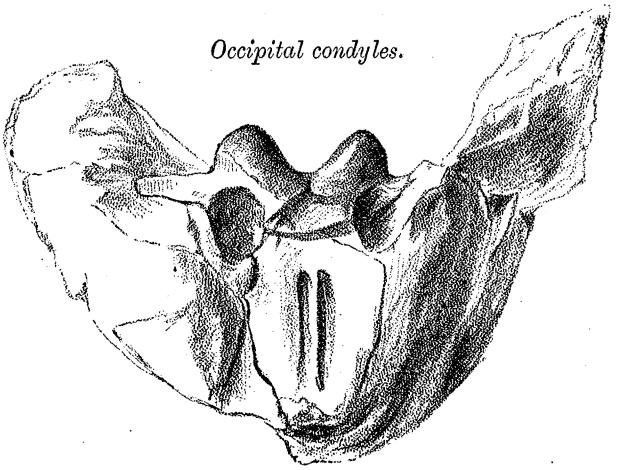
A badly preserved specimen of a skull which has lost a connecting portion between the base of the skull and the jaw collected by Dr. KANNEMEYER from the back of O'Brien, near Burghersdorp, is of interest, as showing the palate (fig. 5) and the

Fig. 3.



Posterior aspect of skull of *Gomphognathus* showing occipital condyles and foramen magnum.

Fig. 4.



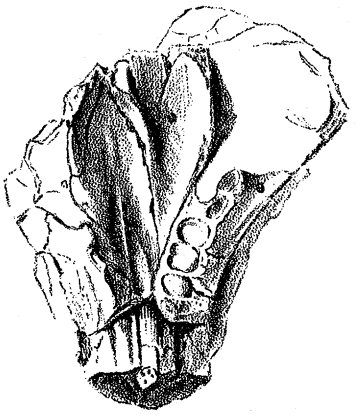
Hinder part of the base of the same skull showing the occipital condyles, as seen from below the auditory region, and the basi-sphenoid region.

occipital condyles (figs. 3 and 4). I have no doubt, from the original condition of the matrix, that the remains are portions of one skull. The condyles are distinctly divided. Their tranverse width is $\frac{8}{10}$ inch. The width of each lateral part is $\frac{5}{20}$ inch; so that there is a notch between the two condyles, which passes vertically downward. Each condyle is hemispherically convex, but they are connected by a narrow area on the base. The sutures in the occipital region are not easily traced, but it seems not

improbable that the concavity between the condyles is formed by the basi-occipital bone. The posterior suture separating the basi-occipital from the basi-sphenoid is transverse, $\frac{7}{20}$ inch in advance of the concavity between the condyles. There is no clear indication of the boundaries of the ex-occipital bones, or of the supra-occipital bones, though the occipital plate was manifestly triangular, concave, and inclined forward, though its lateral borders extend behind the occipital condyles. At the base of each condyle, laterally, is a large foramen, placed between the basi-occipital, basi-sphenoid and ex-occipital bones (fig. 4).

It divides, at its base, into two smaller foramina, which are probably nerve outlets. External to this is the indication of another foramen, which I suppose to be auditory, probably indicating the tympanic bone. The basi-sphenoid is a long triangle, imperfect in front, concavely depressed in the middle, where there is a slight sharp longitudinal ridge, bordered by a narrow groove on each side (fig. 4). The usual compressed ridge in front of this sphenoidal region is lost, as are the descending palatal processes of the post-orbital descending arch.

Fig. 5.



Palate showing the sockets for molar teeth in the maxillary on the right side. The third socket being partly divided on the inner side. The median vomer is flanked laterally by the palatine bones ($\frac{1}{2}$ nat. size).

The palate (fig. 5) is imperfect, being lost in front of the palato-nares. The vomer is about two inches long behind the indication of the palato-nares, where it is $\frac{8}{10}$ inch wide between the alveolar margins of the maxillary bones. It narrows posteriorly in a lanceolate contour, and is concave from side to side; and as it extends forward, a thin vertical median ridge is developed to the hard palate, so as to divide the nares posteriorly. The palatine bone is placed laterally, so that it adjoins the vomer along its length forming an elevated ridge. The parts of the palatine plates preserved are triangular, elongated, and concave, with the anterior point wedged between the vomer and the maxillary bone, opposite the penultimate tooth socket; posteriorly the bones converge; externally there is a prominent ridge-like border to the bone, but the descending processes are not preserved.

Only a portion of the maxillary bone is preserved below the orbit, where it shows indications of apparently five tooth sockets, which are transversely ovate, closely

packed together, but with distinct divisions between the sockets. In the third socket preserved there is a constricted appearance on the inner side, as though the root on that side is deeply grooved or partially divided. Above the tooth sockets, the external bone of the face is convex, and a ridge is prolonged backward external to the alveolar border and above it, which becomes a part of the lateral contour of the skull. Above this ridge the bone is somewhat concave, owing to the development of another ridge, now broken away, at the base of the orbit. The orbit, as indicated, appears to have been vertical, ovate, $1\frac{1}{10}$ inch long and $\frac{8}{10}$ inch deep, and to have looked outward and forward. Parts of the frontal bones are preserved, they show a median suture, and are separated by a lateral suture from the post-frontal bones, which extend backward into the temporal vacuities, as well as outward, so as to divide those vacuities from the orbits. Impressions upon the bone appear to indicate that the pre-frontal was small, and that the nasal bones were narrow.

Specimens from Lady Frere.

In descending the hill at Lady Frere, after obtaining the skeleton of *Cynognathus crateronotus*, I found blocks of stone which had evidently been dislodged from a position above, and transported downward by the rains. They showed portions of the mandible with teeth. I eventually united them, and they were separated from the investing rock in the British Museum, with the result that a skull of this genus was obtained with the lower jaw closed upon the palate. The specimen is complete, except that the occipital region is lost owing to long exposure of the block to atmospheric waste. At the same time the anterior portion of another skull was freed from the same block of stone. I have since found that that specimen fits the somewhat distorted back of a skull which I found in a loose block upon the surface a little lower down the hill. This second example of the skull of *Gomphognathus* has lost the lower jaw, but shows the back of the skull, and the articular region for the lower jaw, so as to complete a knowledge of cranial characters of the genus. The skull, which consists of the two fragments united, is slightly the larger of the two, but is the less complete. On account of its greater technical interest it is described first. It measures from the occipital condyle to the extremity of the snout rather less than $8\frac{1}{2}$ inches, but the concave occipital plate is prolonged backward for more than half-an-inch behind the occipital condyles.

The back of the skull is a little distorted by pressure; and on the right side it is imperfect from weathering, so that the summit of the parietal crest behind is lost as well as the external part of the squamosal bone. Yet enough remains to show that the parietal crest was the apex of the triangle which the occipital plate formed; that the lateral margins of the plate were convex downward and backward, about $3\frac{1}{2}$ inches long, and converged superiorly; and that the base of the occipital triangle, which has the occipital condyles in the middle, was $3\frac{1}{2}$ to 4 inches wide. This

triangular area is concave, both from side to side and from the parietal bone to the foramen magnum; its sides are produced backward, and the supra-occipital region retreats forward above the foramen magnum. The occipital condyles are $\frac{3}{4}$ inch wide, transversely reniform, concave above, convex below, when seen from behind. They are deeply divided by a vertical notch of V-shape, which would completely separate the articulation into two hemispherical parts, but that the condyles are directed downward as well as backward, so that there is a narrow inferior connection between them, which the dividing notch does not sever.

Fig. 6.

Gomphognathus polyphagus.—Occipital aspect of the skull, showing the condyles, foramen magnum, the lateral squamosal bar, and the articular region for the mandible.

The foramen magnum is ovate and vertical, $\frac{4}{10}$ inch deep, and $\frac{7}{20}$ inch wide, with a small transverse notch, which is apparently a nerve outlet just above the condyle; and above this notch the margin of the foramen is more prominent. The lower half of the condyle appears to be formed by the basi-occipital bone, which does not extend posteriorly so far as the ex-occipital bones, which form the hemispherical condyles.

There appears to be a narrow superior border to the foramen magnum for the supra-occipital, so that the sides of the foramen are manifestly formed by the ex-occipitals. The supra-occipital appears to be defined superiorly by a sagittate suture. The bone is about $\frac{8}{10}$ inch high, and $\frac{6}{10}$ inch wide. The bone above it

is to be regarded as the inter-parietal; while the parietal comes on to the back of the occipital plate, external to the inter-parietal, supra-occipital, and ex-occipital. Behind and below the parietal is the imperfectly-defined opisthotic, inseparable from the ex-occipital bone.

There is a small transversely ovate foramen between the ex-occipital, the parietal and squamosal on each side. There is no proof that it passes through the skull wall. Below it the ex-occipital, with which the opisthotic is combined, is flattened and compressed inferiorly to a sharp edge, which extends transversely outward, and forms the inferior contour of occipital plate. But above this foramen, the surface of the parietal is a little convex, so that the supra-occipital concavity is somewhat accentuated. A slightly elevated but blunt median ridge ascends the supra-occipital bone vertically.

External to the triangular concavity of the occipital area the squamosal bone rests upon the parietal as a thin film which descends laterally to the level of the occipital condyles, when it makes a sudden angular bend upward and outward (fig. 6).

The lateral contour of the ascending bar of the squamosal bone is convex, and nearly at right angles to that of the lateral border of the occiput; both are equally thin, and the two plates define a V-shaped squamosal notch which is open superiorly. But the squamosal bone is much more massive than is at first obvious; and below this thin external posterior plate, there is an excavation in the bone, which shows it to be expanded laterally for $1\frac{3}{4}$ inch (fig. 6) beyond the compressed ridge at the base of the V-shaped fold just described.

This posterior surface is convex from above downward as in *Cynognathus*, and convexly rounded on the external margin towards the malar bone, which overlaps it, but it is concave as it extends inward. This process descends below the level of the occiput, and contributes to form the articulation for the lower jaw, which is in advance of the occipital condyles. On its posterior surface are the usual grooves or canals which I have supposed to mark the quadrate bone, which appears to be small, ill-defined, and to form the inner part of the condyle for the lower jaw. The external depth of the squamosal posteriorly is 3 inches, where the malar, which overlaps it, terminates. The external surface of the malar bone is vertical, directed forward and a little inward, and imperfectly preserved; but its basal contour is concave, and directed downward in a sickle-shaped curve, which is partly owing to the development of an inferior descending sub-orbital process, which, however, is rather behind the orbit, and below the post-frontal bone.

On the base of the palate the basi-sphenoid bone is triangular and concave. There is a large foramen at the base of the occipital condyles on each side. A conspicuous depression in advance of these foramina is seen in the median line; and, in front, the converging sides of the sphenoidal triangle become compressed to a median ridge. The transverse ridge in the opisthotic region is altogether behind the articulation for the lower jaw; but the pterygoid plate is given off from the side of the sphenoid,

and extends outward to the articular region of the lower jaw. It presumably meets the quadrate bone, as in Reptiles and Birds, but this is not shown. The edge of the pterygoid is reflected a little downward, so that it appears to enclose a deep excavation between itself and the basi-sphenoid bone. In the hinder part of this excavation there are some indications of a tubular auditory bone which has been chiselled away. It is either a cochlea comparable to the cochlea of Teleosaurs and Monotremes, or a prolongation of the tympanic bone in tubular form. The condyle for the lower jaw, in so far as it is seen, is transverse, an inch wide, and $\frac{7}{20}$ inch from front to back, on a line with the hinder border of the malar, but removed nearly an inch inward from its external surface. This inner position appears to be due partly to the thickening of the inferior descending mass of the squamosal bone. The bone which appears to be the quadrate, from forming the internal part of the articulation for the lower jaw, sends two slender processes upward into the squamosal; processes of the squamosal bone extend between and behind them, so that the suture is not close. The ascending rods of the quadrate bone have an aspect resembling the roots of a molar tooth, as in *Cynognathus* and *Thrinaxodon*.

This form is so absolutely identical with the form of the malleus in a large number of Mammals, that it seems sufficient to re-open the question of the relation between that auditory bone and the quadrate bone in Reptiles. If the quadrate bone is here rightly identified, it would be a remarkable confirmation of the position taken by Professor HUXLEY many years ago in regarding the articulation between the malleus and incus in Mammals as corresponding to the articulation between the quadrate bone and the articular bone of Reptiles. No proof of that interpretation has hitherto been available. If the morphological condition of this quadrate bone is held to be sufficient to identify it with the malleus, there still remains the difference from mammals that the articular bone is largely developed in these fossil animals; and a direct articulation has not been established between the dentary and the squamosal bone, though they are brought into close contact with each other, and the union of the dentary with the articular bone is loosely made.

The crest of the parietal divides the large temporal vacuities from each other. That on the right side is 4 inches long and about $2\frac{1}{4}$ inches wide in the middle. Its external contour is convex, it is truncated in front by the post-frontal, and pointed behind, where the external and internal parts of the squamosal bone converge. The parietal crest widens as it extends forward, becomes flattened superiorly, and margined by an elevated rounded border. This is formed by the post-frontal bone, which appears to extend backward flanking the parietal crest, for more than half its length. The sides of the brain case are compressed transversely, widening posteriorly as in *Elotherium*. At less than an inch below the summit of the ridge is the longitudinal groove, which marks the separation of the parietal bone above from the lateral bones of the brain case below.

The anterior portion of the skull (fig. 7) is $4\frac{1}{2}$ inches long. It is weathered upon the

left side, but otherwise shows every detail of structure both of the external surface and palate, including the dentition, and the sutures between the bones. The posterior fracture is at the back of the orbit and behind the palatine processes which descended in an arch between the rami of the mandible. Hence the orbits, which look upward, outward, and forward, are in the middle length of the skull; but they are imperfectly defined, owing to the loss of the post-frontal bones in the fracture. The diameter of the orbit was about $1\frac{3}{10}$ inch. It is bordered below by the malar, which is overlapped internally by the lachrymal bone, which rests upon the maxillary, and more internally upon the palatine; the last-named bone being wedged between the lachrymal and maxillary so as to be seen below the back of the orbit. The lateral outline of the skull rapidly contracts, and the width diminishes in front of the orbits, becoming narrowest at the extremely small premolar teeth, in front of which the jaw expands transversely in a bulbous snout, at the sides of which are the canine teeth. Anteriorly the pre-maxillary bones ascend as a ridge dividing the terminal nares; and as in other Theriodonts this ridge curves forward in advance of the alveolar border.

The nares are each longitudinally ovate, nearly an inch long and fully half-an-inch wide. The vacuities are inclined obliquely forward and outward; but are parallel to each other. At their hinder margin the nasal bones, which divide them behind, are half an inch wide. Externally, the border formed by the maxillary and pre-maxillary bones is rounded, and descends obliquely as it extends forward.

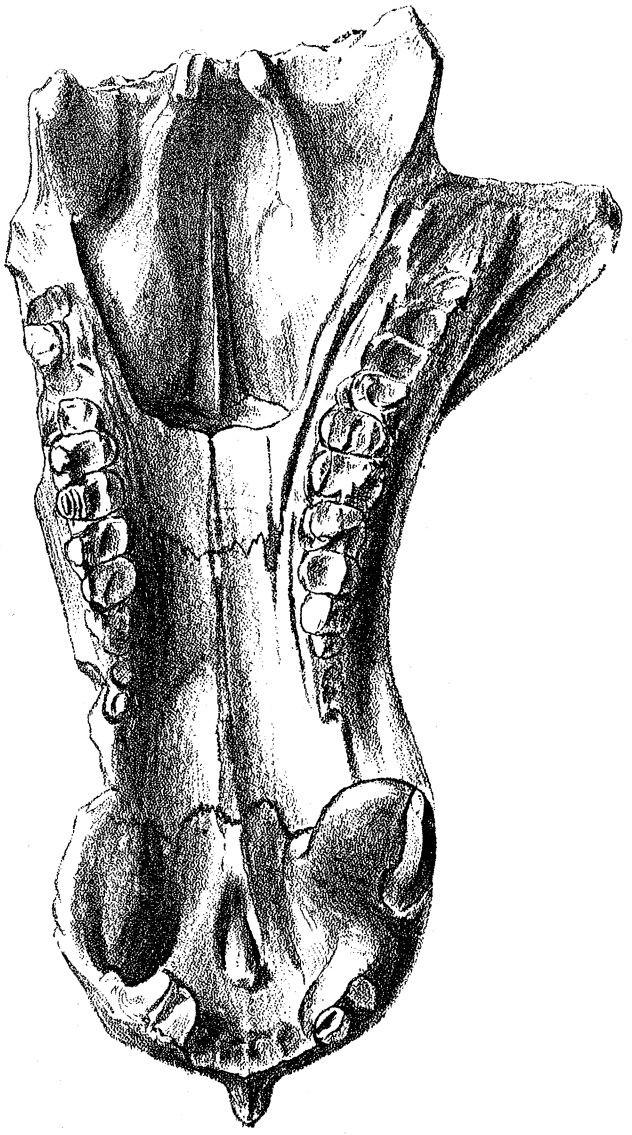
Well-defined sutures separate the pre-maxillary bones from each other, and from the maxillary bones. The transverse width over these bones at the ascending processes on the middle of the sides of the nares is $1\frac{1}{2}$ inch. The height of this process is $\frac{7}{10}$ inch; that of the median internasal process is somewhat more, and the concave notch between them excavates the bone so that it is only $\frac{3}{10}$ inch deep above the second incisor tooth. There are indications of four teeth in each pre-maxillary bone.

The maxillary bone forms the side of the jaw. It is somewhat convex from the alveolar margin upward and has in its posterior part a ridge which leads on to the suborbital descending process, which diverges outward from the alveolar border as it extends backward. The distance from the back of the narine to the front of the orbit on the right side is $2\frac{8}{10}$ inches; and the distance to the anterior extremity of the pre-maxillary bone is $3\frac{8}{10}$ inches. From the anterior border of the orbit to the front of the pre-maxillary suture is $3\frac{3}{10}$ inches. A row of foramina, of which three are conspicuous, extends along the maxillary bone, $\frac{6}{10}$ inch above the alveolar border. The depth of the maxillary in front of the orbit, below the pre-frontal bones is $1\frac{1}{2}$ inch. The nasal bones are narrow, preserved only on the right side. The posterior suture is not distinct, but the nasal bone appears to be less than $2\frac{1}{2}$ inches long, with an average width behind the nares of $\frac{4}{10}$ inch.

The frontal bone is flattened above, divided by a median suture, and appears to be excluded from the orbit. The two bones have straight lateral borders, in which they meet the pre-frontal bones.

The palate (fig. 7) has a median choana, which is ovate. Through it a cylindrical bone like an unenamelled tooth descends, so as to project upon the palate. It is in the position of the anterior end of the vomer displaced, but there is no proof of its real nature to be obtained without destroying the specimen by slicing it. The alveolar

Fig. 7.



Palatal aspect of the skull of *Gomphognathus polyphagus*.

border is moderately elevated all along its extent. A deep pit exists in advance of the maxillary canine on each side, in the positions in which the lateral choanæ are commonly developed in mammalian skulls; as though the absorbent influence of such a tooth received into the upper jaw might be considered in relation to the existence of such perforations in the palate. The premaxillary bones extend upon the palate,

forming its floor for $1\frac{4}{10}$ inch behind the front of the alveolar margin, defined by a well-marked transverse suture. Behind the pre-maxillaries, the slight median ridge which divides the palate anteriorly into two shallow concave channels dies away posteriorly; and the palatal plates of the maxillary bones form a hard palate for a length of $1\frac{3}{10}$ inch, meeting each other in the median line, and extending back as far as the first three molar teeth (fig. 7). Behind the maxillary bones the hard palate is continued backward by the palatine bones which join the maxillary plates by a W-shaped transverse suture, and extend back for about $\frac{7}{10}$ inch. The width of the palate is narrowest at this suture, where it is $\frac{13}{20}$ inch between the inner alveolar borders. Where the hard palate terminates transversely in a concave posterior truncation, its bony vault is distinctly concave from side to side.

The truncation exposes the posterior nares, which are seen as two vertically ovate channels, which appear to be separated by the median vomerine ridge, which descends to meet the palatine bones. The palatine bones are prolonged backward laterally, parallel to the maxillary bones, with which they are in contact, so that they are wedged between the vomer and the alveolar plates of the maxillary bones. They, therefore, form the entire walls of the posterior nares, except for the median dividing vomerine ridge. From the palato-nares, the two convex ridges which extend backward on each side of the median ridge become smaller and narrower as they pass backward beyond the median ridge, and form two small compressed rounded eminences which approximate towards each other. A distinct ossification is seen in this specimen upon the right side, which is external to the palatine bone. It is compressed from above downward, is directed downward and backward. It extends inward to the ridge, terminating in the small mammillation just described. Its external border is reflected forward, so as to present a vertical lateral truncation, more than $\frac{1}{2}$ inch wide and about $1\frac{1}{4}$ inch deep, as preserved. This would, therefore, be the transverse bone, and it is developed with exactly the same form as that element of the skull in Lizards and Crocodiles, in contrast to the Dicynodonts, in which no transverse bone, or such an ossification, is found. The distance from the termination of the hard palate to these processes is about 2 inches, and the transverse width across them, when complete, was somewhat more. Thus far the palate is $5\frac{1}{4}$ inches long.

There appear to be four incisor teeth in each pre-maxillary bone, but the central four, two in each pre-maxillary, were lost before fossilization. The teeth are compressed from front to back, so as to form sharp lateral borders. The outermost tooth on the left side shows the edge to be serrated. The external surface is slightly ridged, and the base of the crown is thickened, so that its inner side is more convex than the outer side. The transverse measurement in a straight line over the pre-maxillary teeth is $1\frac{3}{10}$ inch. Each crown is $\frac{3}{10}$ inch high as preserved, but all are broken. The outermost left tooth, which is enamelled for half its length, appears to have been worn with use during life; this tooth is below the pre-maxillary suture. There is an external scale-like sub-narial ossification behind this suture reaching

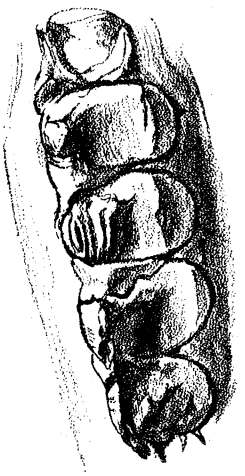
from the narine to the alveolar border, $\frac{3}{10}$ inch wide in the middle, which corresponds to the sub-nasal ossification which I have indicated in *Pareiasaurus* and some species of *Dicynodon*.

Behind the incisor teeth is a toothless interspace in the jaw of $\frac{3}{10}$ inch, with a thin alveolar margin excavated on the inner side into a deep concavity for the reception of the mandibular canine tooth.

On the left side, the maxillary canine tooth is almost entirely lost with the adjacent part of the side of the face. On the right side it is a powerful tooth an inch long. Its extremity is obliquely worn on the external surface by use during life, like the incisor. The canine is compressed, $\frac{6}{10}$ inch from front to back at its socket, half this measurement at its worn extremity, and more than half as thick at the base of the crown. Its front border is convex; its hinder border is concave; both these edges are transversely serrated; the surfaces of the tooth are convex and traversed by ill-defined longitudinal ridges. The crown descends vertically, inclining slightly outward. The curve of the root of the tooth upward and backward in the maxillary bone determines the smooth bulbous convexity of the snout.

Behind the canine teeth the external contour of the alveolar border rapidly contracts transversely, but without much alteration in the internal contour, to form the short diastema, which is raised a little above the palate, and about $\frac{9}{20}$ inch long. Its inward curve is continued by the small pre-molar teeth. These are apparently six in number on each side. The first on the left side appears to be worn down with use, but all the others are broken or lost. The crowns increase a little in size, and all are contained in a length of half-an-inch.

Fig. 8.



Five molar teeth from the left side of the skull of *Gomphognathus polyphagus*, showing the elevated external cusp and the ridge which descends from it posteriorly upon the flat crown. ($\frac{2}{1}$ nat. size.)

The maxillary teeth in lateral contour are convex from front to back. On the palate the teeth of the two sides diverge as they extend backward. They are nine

in number in each maxillary, packed in close succession to each other, as in Rodents. The crowns are transversely ovate; those in the middle of the series are the largest, where four in longitudinal succession measure 1 inch, and the fourth and fifth are fully $\frac{4}{10}$ inch wide. On the right side the last three are missing from their sockets, and the last three on the left side appear to be imperfectly cut, and are, in any case, imperfectly preserved: they are all behind the hard palate. The crowns of the molar teeth are characterized by convex external enamelled surfaces. This surface in each tooth terminates in a strong cusp, from which a ridge descends inward and somewhat backward upon the crown, which is relatively a large flattened ledge (fig. 8), slightly concave on each side of the transverse ridge already described, but in every case worn more or less level, as though there were a horizontal rodent-like movement of the lower jaw, as well as a vertical biting movement. The former condition may explain the circumstance that the pit in the maxillary which receives the mandibular canine is six-tenths of an inch long, while the part of the canine which fitted into it measured presumably less than half as much.

Gomphognathus.

This specimen from Lady Frere consists of the skull and lower jaw and may belong to the same species as the skull just described. As preserved, the extreme length of the skull is 9 inches, and the extreme width is about $6\frac{1}{2}$ inches towards the hinder part of the temporal vacuity. The occipital plate, together with the hinder articular extremity of the squamosal region on the right side is lost, and the hindermost angle of the squamosal bone on the left side where its superior margin forms a V-shaped fold is imperfect at the base, from an accident in removing the matrix. The skull is depressed, and the lower jaw displaced, so that the articular element, instead of being attached to the squamosal, passes upward into the back of the temporal vacuity above the pterygoid bones. The articular bones are displaced a little inward and upward from the dentary bones, which are but little disturbed from their natural position, though pressed closer upon the palate than is usual.

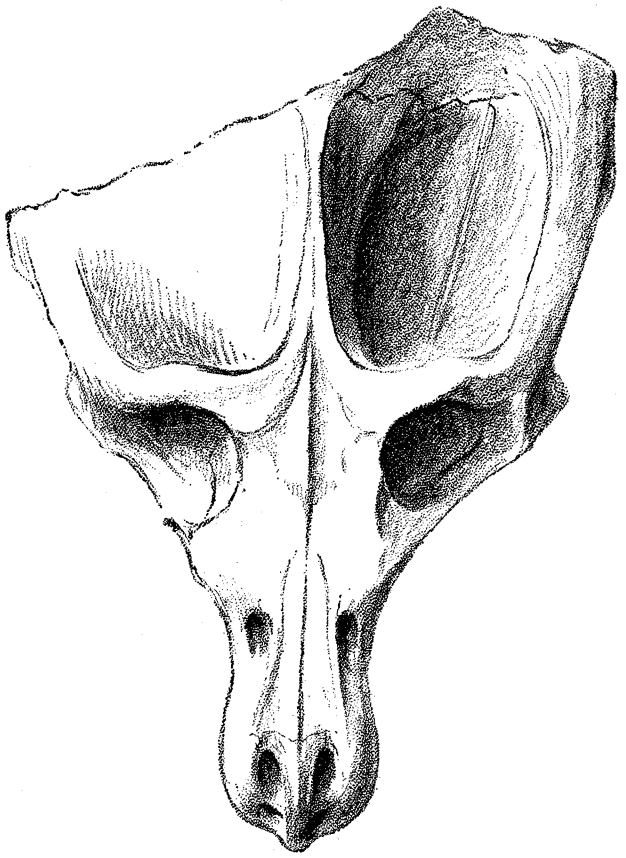
The contour of the skull seen from above is remarkable for the great transverse measurement over the temporal vacuities, where the malar bones only converge slightly forward, measuring above 5 inches transversely at the back of the orbit. The inferior orbital borders converge forward obliquely, so that the transverse measurement in front of them only slightly exceeds 2 inches; and then the sides of the snout are somewhat concave between the orbit and the canine, without any conspicuous bulbous expansion, owing apparently to the moderate size of the canine tooth. The anterior extremity of the snout is rounded in the usual way, with a strong elevated internarial septum, formed of the nasal and pre-maxillary bones; and this septum extends forward in front of the alveolar border, and defines the nares as longitudinal grooves rather than foramina, because their anterior borders are excavated in the pre-maxillary bones as concave notches.

The snout is not so slender as in *Pistosaurus*, but the skull rather suggests that type than any triassic reptile.

The head is flattened above, with a distinct slight concavity in the inter-orbital region, and it may be very slightly depressed by compression, since the sutures of the post-frontal, pre-frontal, and maxillary bones are defined by the bones having yielded a little along the sutural lines.

The distinctive defining characters of the upper surface of the skull are in the size, positions, and aspect of the temporal vacuity, orbits, and anterior nares (fig. 9).

Fig. 9.

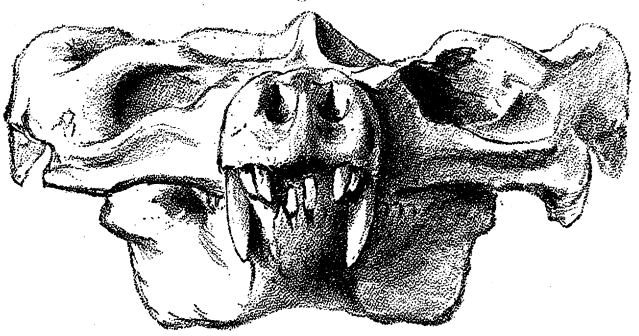


Superior aspect of the skull of *Gomphognathus*, showing the nares, orbits, and temporal vacuities. ($\frac{1}{2}$ nat. size.)

The temporal vacuities are large and longitudinally ovate or sub-rhomboid. The extreme transverse width of each is $2\frac{1}{2}$ inches in the middle, and the extreme length, measured obliquely, is $4\frac{1}{2}$ inches; but the outer posterior angle is imperfect owing to loss of a fragment of bone (fig. 9). On the outer side of the temporal vacuity the squamosal bone forms the hinder part of the zygoma; and, as it extends forward, this element is wedged between outer and inner parts of the malar bone. In front the temporal vacuity is bordered externally by the malar, and internally by the post-frontal; the latter forms a transverse bridge $\frac{7}{20}$ inch wide, separating the vacuity from the

orbit. From the convexity of the post-frontal from within outward, the bone makes an elevated angular transverse superciliary ridge. The internal border of the bone is the median crest of the skull, about $\frac{6}{10}$ inch wide in front, narrowing to a tenth in the middle length. This anterior spear-shaped part of the median crest is bordered on each side by the posterior extension of the post-frontal bones, behind which the parietal bones emerge, concave in length laterally, and from above downward at first, passing into an inferior longitudinal convexity below, as the back of the skull widens from side to side. At the base of this convexity posteriorly, another bone is seen in the position of the pro-otic. The hinder border of the temporal vacuity is made by the squamosal bone; which, resting upon the parietal, descends, widening so as to make the U or V-shaped posterior contour. Its posterior edge appears to be convex; its width at the base is about $1\frac{3}{10}$ inch, as exposed.

Fig. 10.



Anterior aspect of the same skull, showing the anterior dentition, positions of the nares and orbits, and position of the mandible.

The orbits seen from the front have the aspect of being small and circular, and of looking forward. Seen from the side they have a triangular aspect, owing to the way in which the flattened floor of the orbit is margined by a straight ridge which descends a little as it extends backward (fig. 10). A similar ridge on the hinder border contributes to the triangular outline. Seen from above the orbits appear to converge inward (fig. 9) and expose the posterior and inferior surfaces of the bones which border them. Owing to the existence of the lateral ridges, it is not easy to accurately define the size of the orbit. Its vertical measurement, taken internally, is $\frac{8}{10}$ inch, but taken to the external ridge on the malar in front, it is almost half as much again. Similarly the antero-posterior extent may be given at $1\frac{2}{10}$ inch; or, if extended to the posterior ridge behind the orbit on the malar bone, it will be $1\frac{1}{2}$ inch. The width of the flat interspace between the orbits is $1\frac{6}{10}$ inch. It is formed by the frontal bones in the middle, external to which are the pre-frontal bones. The anterior border of the orbit is $3\frac{6}{10}$ inches behind the anterior extremity of the snout. In the anterior angle is a large vertical lachrymal foramen, situate in the lachrymal bone, which is well developed in front of the orbit, and meets the pre-frontal bone on its upper margin, rests upon the maxillary bone behind, and meets the malar bone below. The malar

bone makes the inferior orbital border, resting upon the external post-alveolar ridge and process of the maxillary bone. Behind the orbit the malar bone is prolonged downward in the process, not perfectly preserved, which recalls that seen in certain Edentates and Marsupials, and in *Elotherium*. Superiorly the malar sends a process upward and inward at the back of the orbit, to meet the process of the post-frontal bone, which is directed transversely outward. The depth from the superior to the inferior processes of the malar is about $2\frac{1}{10}$ inches. The malar bone contracts concavely behind these processes, both superiorly and inferiorly, but the inferior concavity is the deeper of the two, and then the nearly vertical plate of the malar bone is prolonged backward and downward to the articular region of the mandible. Below the orbit the bone is concave between its superior ridge and the inferior ridge, the latter rising above the alveolar border, and being prolonged backward and outward till it passes into the descending malar process. The depth of the malar in front of the articulation is $2\frac{1}{2}$ inches. It appears to descend vertically.

The nares, in the front of the snout, are two parallel longitudinal grooves, divided from each other by a narrow vertical median bar, formed by the prolongation forward of the nasal bones which meet the ascending process of the pre-maxillary, which arches convexly forward. The anterior border of the pre-maxillary seen from above is flattened, and inclined downward, slightly concave from front to back, and bordered posteriorly by a sharp ridge, parallel to the anterior contour. The narine proper lies behind this anterior bar, which is fully $\frac{4}{10}$ inch wide. The true nares are about $\frac{6}{10}$ inch long and $\frac{3}{10}$ inch wide, with the contours sharp back and front. The pre-maxillary bone does not appear to extend behind the incisor teeth, of which there appear to have been four in each bone, though the middle four, as in the other skull from Lady Frere, are missing.

The measurement from the median suture to this suture is fully $\frac{8}{10}$ inch. As in so many other examples of Theriodonts, a distinct scale lies between the pre-maxillary and maxillary, entering into the outer border of the narine ; but it does not descend to the alveolar border where the pre-maxillary meets the maxillary bone. The nasal bones appear to be $3\frac{1}{4}$ inches long, and to form the inner and hinder borders of the nares, into which the maxillary bones enter at the outer hinder border. The nasal bones are in contact with the maxillary bones laterally. The lateral external contour is concave on each side, the concavity being defined by a hemispherical pit upon the convex part of the maxillary bone which is opposite to it. Towards the pre-frontal the nasal bones widen. The maxillary bones are nearly vertical and form the sides of the snout, rounding superiorly and contracting transversely behind the canine teeth, but this does not give so bulbous a form to the snout as in the other skull, because the canine teeth are smaller.

The antero-posterior extent of the maxillary bone, from the last incisor tooth to the end of the post-alveolar extension, is $3\frac{8}{10}$ inches. In this area the maxillary teeth appear to occupy 2 inches. The greatest vertical depth of the maxillary is $1\frac{1}{4}$ inch,

above the ovate lateral pit already described as approaching towards the nasal bones. The transverse width at the hinder termination of the maxillary bones below the orbits is equal to the lateral extent of the maxillary bone. The least transverse width over the maxillary bones is on the alveolar border where the molar teeth commence. This measurement is $\frac{8}{10}$ inch. Between this region and the narine, the anterior part of the maxillary bone is smooth and convex, so that the snout is slightly bulbous. The region posterior to the canine tooth is concave in length, but convex in depth. The sub-orbital foramen is placed a little further back on the left side than on the right side. It is more than $2\frac{1}{2}$ inches from the extremity of the snout, is inconspicuous, and just in advance of the anterior lachrymal suture.

The dentition is imperfectly exposed owing to the extremely close way in which the skull and mandible are pressed together.

There are indications of eight pre-maxillary teeth, four in each bone. The sockets are defined for the middle four teeth but the teeth are not preserved. This may be attributable to the small depth of their roots consequent upon the anterior excavation of the bone above by the nares. The loss may have taken place during life. The third tooth appears to have been the largest, the fourth is smaller than the third. These teeth are flattened externally, slightly ridged, thinly enamelled, and the enamel does not extend to the base. The antero-posterior extent of the four teeth is $\frac{7}{10}$ inch; and the third tooth, as preserved, has a crown which descends $\frac{9}{20}$ inch below the alveolar border and is imperfect at the extremity apparently from wear (fig. 10). The base of this tooth is $\frac{2}{10}$ inch wide. The middle two teeth in the mandible are exposed, and are narrower than the third and fourth in the pre-maxillary. But no other mandibular teeth are seen in this region. There is a diastema of $\frac{3}{10}$ inch between the incisors and the maxillary canine, and this interspace presumably corresponds to the position of the mandibular canine.

The canine tooth is compressed from side to side, descends vertically and slightly forward, is pointed, with a tendency for the point to be recurved, and on both sides the anterior margin is worn flat at the extremity, which projected slightly below the mandibular symphysis. The base of the tooth is half-an-inch wide. Its length as preserved is $\frac{19}{20}$ inch. No indication is preserved of serrations on the anterior margin, and the posterior margin appears to be cutting, but the condition of the specimen is not conclusive that serrations are not developed. The external surface is characterized by flutings not unlike those of the incisors.

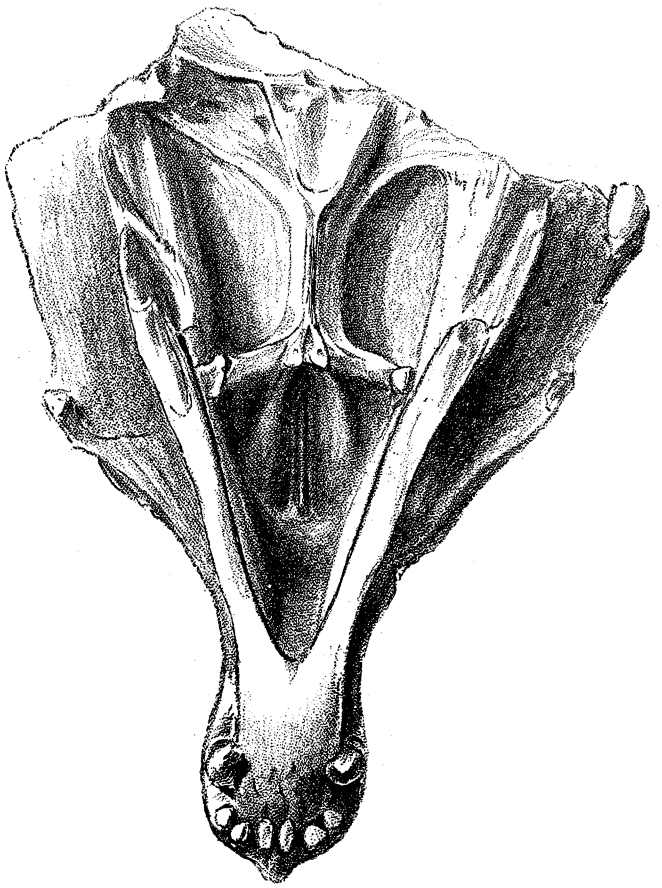
Behind the canine is a diastema which appears to be about $\frac{8}{10}$ inch long; and then follow not fewer than nine maxillary teeth, which are broad, short, convex externally, and terminate at the external extremity in a cusp. The length of the alveolar space is $1\frac{17}{20}$ inch. Very few of the mandibular teeth are indicated. Two teeth seen in front on the left side are comparatively large; a few are seen on the right side, but in no case is the form of the crown of the tooth seen.

The palate has been exposed as far as possible, seeing that the mandible is in position (fig. 11).

The palatine bones form the back of the hard palate, which is concave from side to side. Its posterior margin is truncated transversely at $3\frac{2}{10}$ inches behind the extremity of the snout; this contour is concave from side to side because the lateral margins are produced horizontally backward.

Behind and above the hard palate is the posterior channel of the palato-nares, which is a lanceolate concavity $1\frac{3}{4}$ inch long, tapering behind, and divided at the base by a sharp narrow median longitudinal ridge upon the vomerine bone. This

Fig. 11.



Palatal aspect of the same skull, showing the contour of the mandible upon the skull, the palato-nares, transverse-palatine arch, and pterygo sphenoidal-area.

concavity is bordered laterally by ridges, which become sharper as they converge backward towards the middle line of the palate, and develop a pair of tubercles on that part which lies between the descending processes to which the transverse bones contribute (fig. 11).

These processes form an arch in the usual way, which descends laterally so as to abut against the inner side of the mandible, by a surface which is flat on the external side. Each process is flattened behind and oblique in front, so that the anterior edge

is sharp. It measures half-an-inch from front to back, and about $1\frac{1}{10}$ inch deep as preserved, with the internal surface rounded below and sharp above, and separated by a slight groove from the palatine ridge already described. The transverse width over the extremities of these processes is rather less than 2 inches. They are 5 inches behind the anterior extremity of the snout. Their anterior faces are concavely excavated, so as to form triangular concave areas external to the palatine ridges. The sutures are not distinctly enough seen in this specimen to justify the recognition of the transverse bones as elements in the descending processes.

Behind these processes which extend transversely and very slightly forward, is the sharp median keel of the palate, which consists chiefly of the pterygoid bones, abutting laterally against the sphenoid, so as to form first a sharp median keel, $1\frac{1}{2}$ inch long, between the triangular basi-sphenoid bone behind, and the small mammillate processes between the descending transverse bones in front (fig. 11).

Secondly, the pterygoid bones form the lateral ridges upon this median bar, which expand transversely outward above the sides of the basi-sphenoid, extending towards the region of the quadrate part of the articulation, apparently meeting the opisthotic behind, so as to enclose a small transverse pterygo-opisthotic foramen, in the sub-triangular concavity, which is thus bordered by the opisthotic ridge behind, the pterygoid ridge in front, and the basi-sphenoid ridge internally. Lying within this pterygoid ledge, on the left side, is a displaced slender bone which was attached laterally to the sphenoid at about its junction with the basi-occipital and opisthotic. This bone appears to have been nearly $1\frac{1}{2}$ inch long, but not more than $\frac{1}{4}$ inch wide at the extremities, and narrower in the middle. A part of it is preserved resting upon the hinder edge of the transverse pterygoid process on the right side. It appears to have been hollow, and the external bony tissue is cellular. I believe it to be the bone which among Dicynodonts I have regarded as opisthotic, and the bone which Mr. E. T. Newton, F.R.S., has termed basi-pterygoid in *Scaphognathus*. I regard it as extending transversely outward to the quadrate, and as being an auditory bone. It may be the tympanic, and represent a rudimentary cochlea.

A remarkable feature in all these animals is the vertical position which the pterygoid assumes in advance of these posterior transverse expansions, so that their inferior edges converge in the median ridge which embraces the posterior extremities of the vomerine bones, between which, however, no median suture is distinguishable in this specimen.

The triangular surface which I have termed basi-sphenoid is $1\frac{1}{10}$ inch long, and about $1\frac{2}{10}$ inch wide. It is concave, bordered by sharp lateral ridges, which converge anteriorly and rise into the median keel. There are small longitudinal blood-vessels at the base of the inferior concavity.

The occipital condyles are broken away behind; but at their bases are foramina, large and triangular, which form the outer angles of this hinder basal area, the hinder half of which is probably made by occipital bones.

The occipital plate shows the foramen magnum, which was $\frac{4}{10}$ inch high and nearly as wide, sub-circular in form, with a median groove at the base, such as is usually found to divide the occipital condyles from each other. Above the foramen magnum the occipital plate was concave, but the matrix has not been removed. On the left side, the ex-occipital and opisthotic extend transversely outward for fully $1\frac{1}{2}$ inch towards the quadrato-squamosal area, terminating inferiorly in a sharp ridge, which is concave from within outward.

The height posteriorly from below the foramen magnum to the summit of the parietal ridge is $2\frac{1}{4}$ inches; and the transverse measurement of the skull posteriorly as preserved is about 7 inches.

The mandible is of the usual form in this group of Reptiles. The symphysis is obliterated, and the symphysial region is contracted and laterally vertical between the canine teeth, and it retreats convexly from before backward to the inferior divarication of the rami. The length of the symphysis, measured externally, is $1\frac{3}{4}$ inch.

Only the median two incisor teeth are seen (fig. 10); and there is no evidence whether the jaw contained three teeth on either side, or four. The transverse width behind the canines is one inch. The length of the mandible, to the articulation on the articular bone, exceeded 7 inches. The width of the rami posteriorly, as preserved, is less than 5 inches. The rami are compressed and vertical. Each is formed on the external surface by the dentary bone, which increases in depth posteriorly to the angle of the jaw, behind which the contour retreats obliquely upward, parallel to the superior edge of the coronoid process. The basal edge is rounded from side to side, slightly convex in length, with a slight lateral concavity in advance of the angle, which helps to emphasize its stout prominence. The angle is $5\frac{1}{4}$ inches behind the anterior extremity; and the transverse external measurement at the angle is $3\frac{1}{2}$ inches, the jaw being nearly $\frac{1}{4}$ inch thick. Behind the angle, the dentary bone is compressed to a sharp edge. The splenial bone lines the middle portion of the ramus as a splint, which extends back somewhat behind the angle, being embedded in the dentary bone (fig. 11). Above the splenial, and behind the transverse bones are seen the coronoid bones, which are small scales of oblong form, more than $\frac{1}{2}$ inch long and $\frac{1}{4}$ inch deep. Between the coronoid scale and the splenial are the angular and articular bones, which extend back side by side, forming a bar which is internal to the dentary bone. The inner of these bones expands transversely inward; the outer expands transversely outward. They form the articular condyle, with the posterior margin of the dentary upon its external surface; but there is no evidence whether more than one bone enters into the condyle. The bones are somewhat displaced, being drawn away laterally from the edge of the dentary bones, and displaced upward, so that the articular surface is superior to the pterygoid bone, and is exposed in the temporal vacuity on the left side,

A Lumbar Vertebra of Gomphognathus.

A vertebra was found at the back of the skull of *Gomphognathus*, just described, which may possibly belong to the skeleton; though, being an isolated vertebra, this conclusion can only be based upon its size and Theriodont characters. It closely resembles the lumbar vertebræ of *Cynognathus*, though it is much smaller. The centrum is imperfect, its anterior face is about $1\frac{3}{20}$ inch wide, and $\frac{3}{4}$ inch deep, broadly pentagonal, with the two inferior margins converging downward, and the two superior margins inclined to each other so as to converge upward, if they were not interrupted by the neural canal, which is less than $\frac{3}{10}$ inch wide, and is wider than deep. The ribs are anchylosed to the side of the centrum, and the capitular surface is level with the anterior face of the centrum, but the tubercular part is thrown a little backward so as not to reach further forward than the base of the prezygapophysis, and so as to correspond to the transverse process of the neural arch with which it articulates. There appears to be a vertebral canal carried between these portions of the rib. The transverse process is compressed from above downward, and appears to form a slight convex shoulder superiorly where it unites with the rib. The sutural union of the rib-head with the vertebra is close to the concave articular face of the centrum. The anterior face of the rib, as preserved, is straight. The antero-posterior measurement of the rib is $\frac{11}{20}$ inch. Its outward extension from the neural spine is 2 inches. It develops a posterior process which is slightly concave on the under side, and angular above on the outward expansion, and presumably overlaps the similar rib of the next vertebra. The anterior margin of this process is broken, but its antero-posterior extent is $1\frac{3}{10}$ inch. This makes the posterior contour concave, and shows that the interpleural space enclosed by the ribs and vertebra was transversely ovate and inclined a little inward and backward; the external border of the rib is directed a little downward and is sharp. The pre-zygapophyses, which rise from the front of the transverse process, are just behind the face of the centrum, so that there is an excavation below each, external to the neural canal. Their facets are directed inward and somewhat upward. They are divided from each other by the neural spine: the measurement over them is $\frac{13}{20}$ inch. The neural spine is a sharp ridge which ascends obliquely backward, with the sides of the neural arch inclined, so that the transverse section of the arch is an equilateral triangle half-an-inch high. The vertebra appears to have been about an inch long; including the ribs, 4 inches wide; and $1\frac{1}{2}$ inch high to the summits of the neural spine. It is the only evidence of the vertebral column in an animal of the size of the *Gomphognathus*.

A Theriodont Humerus referred to Gomphognathus.

Near the foot of the hill at Lady Frere, with the other remains now described, I found two large weathered concretionary blocks, which showed a fracture through a

curved bone. The matrix has been removed in the British Museum by Mr. RICHARD HALL, and the specimen shows the nearly complete right humerus. It is so similar in character to that demonstrated by the larger fragments of the humerus of *Cynognathus* obtained higher up the hill, that it might belong to the same genus; it is about $5\frac{1}{2}$ inches long, and might have been referred to such a species as *Cynognathus Berryi*. Except for the transverse elongation of the head of the humerus and the development of the radial crest, the bone is in every respect comparable to the humerus of a Marsupial Mammal, characters which indicate, I think, generic difference; while it was associated with *Gomphognathus*. The most remarkable features which it shows are:—(1.) The proximal and distal ends are nearly in the same plane. (2.) There is a hemispherical olecranon pit above the distal articulation on the superior surface (fig. 12). (3.) There is a cartilaginous tuberosity on the inner side of the distal end of the bone, which only differs from that of the Marsupial in being more compressed from above downward and relatively longer. It similarly receives the slender oblique bar which defines the large ent-epicondylar foramen (fig. 13). (4.) The foramen is similarly on the inner margin, ovate, and descends downward and outward, the only difference being that its superior border is not quite so much excavated in the fossil as in the recent type. The foramen is mammalian in distal position. (5.) The external border of the bone distally is similarly compressed to form a sharp distal crest, which is somewhat sharper apparently in the recent form than in the fossil (fig. 13). (6.) The curvature of the shaft is the same. (7.) There is a similar flattening of the inferior surface proximally internal to the radial crest; but the radial crest in the fossil extends more than half the length of the bone (fig. 13), while in the recent form the radial crest is less than half the length of the bone, and is only conspicuous at its termination towards the middle of the shaft. (8.) In the recent Marsupials the articular head of the bone is hemispherical, while in the fossil it is triangular, with the width greatly exceeding the depth (fig. 12). It is interesting that the most striking differences from the Marsupial humerus are in the characters of the proximal end, because the shoulder-girdle is differently constructed in the two groups of animals. But, although the *Ornithorhynchus* has the proximal articulation transversely elongated, and the radial crest more developed than among Marsupials, and thus far makes a nearer approximation to *Gomphognathus*, yet the preponderating resemblances in form of the bone, absence of twist, and characters of the distal end are so great as to suggest that the affinities are far stronger with the Marsupial type than with a Monotreme.

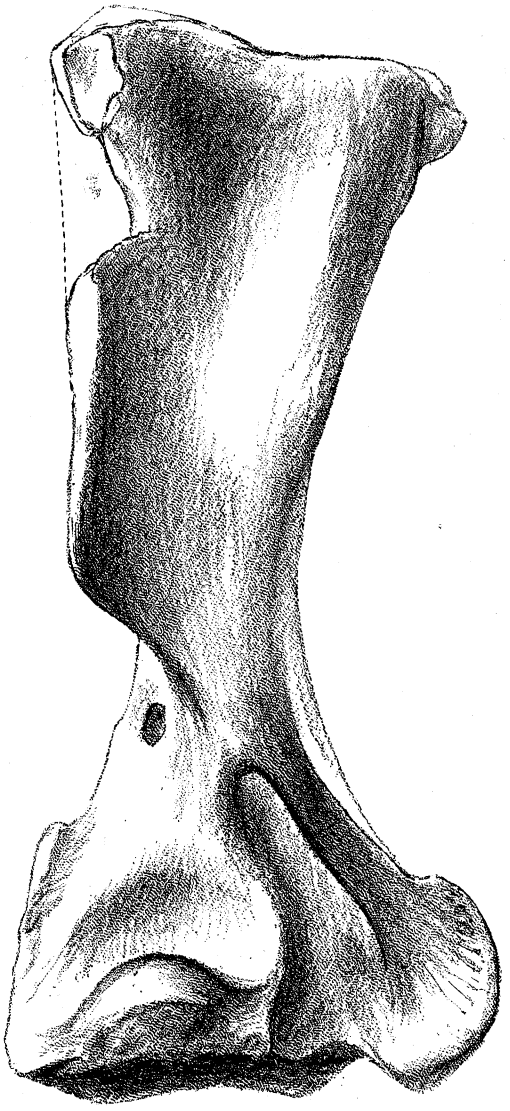
The proximal end of the bone is $2\frac{2}{10}$ inches wide, and, as preserved, 1 inch deep, but was originally somewhat deeper. The depth is greatest towards the radial side, so that the superior surface has a long internal side measuring $1\frac{7}{10}$ inch, and a short internal side measuring 1 inch, which is manifestly due to the loss of part of the thin radial crest (fig. 12). In general character the proximal articular surface is like that afterwards to be described in *Cynognathus crateronotus*. The convexity being towards

the radial margin, and the saddle-shaped part internal. The thickness of the shaft in its proximal part is rather less than half-an-inch, but in the middle it is almost $\frac{7}{10}$ inch. With this increase in thickness it becomes narrower, the width towards the lower part of the radial crest being about $\frac{7}{10}$ inch thick.

Fig. 12.

Superior aspect of the right humerus referred to *Gomphognathus*, found in two blocks of stone, and extracted from the rock in fragments, which are now united together.

Fig 13.



Inferior aspect of the right humerus referred to *Gomphognathus*, showing the radial crest, the two epi-condylar foramina, and the principal distal condyle. Natural size.

The radial crest terminates at $3\frac{2}{10}$ inches below the proximal articular surface. It is directed downward and outward, but not so as to make an angle with the shaft, which is convex from side to side superiorly (fig. 12) and longitudinally channelled

on the under side (fig. 13), the concavity becoming wider and deeper below the proximal articulation.

The radial crest is about $\frac{2}{10}$ inch thick, with its margin slightly thickened and rounded and obliquely truncated at the inferior termination (fig. 13). It makes an angle of 45° with the axis of the proximal articulation.

The distal end widens transversely to $2\frac{1}{2}$ inches, so that its distal expansion gives the shaft the aspect of being constricted from side to side; and its lateral contours are concave when the radial crest is directed downward. Similarly when the bone is seen from the inner side, its superior longitudinal contour is concave, and its inferior contour is convex. Like the proximal end, the distal end has a general aspect of compression from above downward.

The distal condyles are truncated, possibly by exposure. They comprise a larger external condyle (fig. 13), and a smaller internal condyle (fig. 12). The former is $1\frac{1}{20}$ inch deep. The constriction between them, which is prolonged upward upon the superior surface, is $\frac{8}{10}$ inch deep, and the outer condyle appears to be $\frac{19}{20}$ inch deep. These are the proportions seen in the Marsupial humerus. Internal to the condyle, the bone is greatly compressed, and then thickens again to form the internal tuberosity, which is convex on the superior surface (fig. 12) where it is separated from the condyle by a channel, like that which divides the condyles from each other. The depth of this tuberosity is 1 inch; its lateral aspect is lunate, and it is about $\frac{4}{10}$ inch thick. A concave excavation separates it distally from the condyle, below which it appears to descend slightly (fig. 12).

The transverse width of the bar which arches over the foramen, which is seen on the under side, is $\frac{3}{10}$ inch (fig. 13). The foramen is $\frac{7}{10}$ inch long and $\frac{1}{4}$ inch deep on the inner lateral margin, but a groove prolongs it distally to the tuberosity, and the descending groove on the inferior surface of the humerus gives it the aspect of much greater vertical extent. A convex ridge extending towards the outer condyle defines the inferior side of the foramen (fig. 13). There is a concavity above the major half of the condyle on the inferior aspect of the bone, and this reduces the thickness through the bone to the olecranon pit to $\frac{2}{10}$ inch.

The external border of the bone is compressed, but owing to the convexity of the superior surface, its margin is towards the under side (fig. 13). This margin is about 2 inches long and is fractured on the upper $\frac{3}{4}$ inch, so as not to be quite so wide in the specimen as it was originally, and this fracture gives its upper part the appearance of being more compressed, as well as of curving towards the upper side of the bone, which was probably its true condition. At $1\frac{6}{10}$ inch from the distal end, and separated from the external border by about its own diameter, is the small ovate ect-epicondylar foramen, situate in about the same position as in the humerus of *Cynodraco*. This margin of the bone is altogether thicker than in the Marsupials with which I have compared it, but it terminates superiorly in the same abrupt way, where the shaft becomes more nearly cylindrical, below the radial crest.

In describing the humerus referred to *Cynodraco*, Sir RICHARD OWEN compared the bone chiefly with that of the Mammalian genus *Felis*, noticing that the deltoid ridge was of similar basal extent, but more produced, and much thinner.

The ent-epicondylar foramen was found to be more highly placed, and further from the articular surface for the ulna than in *Felis*.

The olecranon pit is said to be represented by a mere wide shallow depression.

In the fossil now described, however, with the single exception of the relatively smaller size of the olecranon pit, all the characters of the distal end of the bone found in the genus *Felis* are intensified; but the closer parallel seems to me to be with Wombats and other Marsupials. Sir R. OWEN also remarks that, apart from the Mammalian proportions, and the ent-epicondylar foramen, the modifications of the humerus better accord with *Omosaurus* than with the humerus of the cat tribe, or any other Mammal; the significance of that resemblance will be considered hereafter.

II. SKULL OF *Microgomphodon oligocynus* (Plate 1, figs. 1–4).

A skull, $2\frac{1}{2}$ inches long, of sub-triangular form, slender in front of the orbits, and about 2 inches wide behind them, was collected by Mr. ALFRED BROWN at Aliwal North. It indicates a new genus of Gomphodont Reptiles, in which the skull has at first sight a general resemblance to *Galesaurus*. It is distinguished among other characters by the comparatively large size of the front pair of mandibular incisors, and the general strength of the conical-pointed incisors, which appear to number three in each ramus, and in each side of the jaw. Secondly, the canine teeth are not differentiated from the incisors, being of the same size. Thirdly, the molar teeth, which in the lateral aspect appear to be small blunt cones, are seen on the palatal aspect to be flattened crowns with many small cusps. The specimen is crushed and somewhat imperfect, especially in some characters of the region behind the orbits, and on the inferior margin of the mandible; but the matrix is so intractable that no further development of the specimen appears to be possible.

The terminal nares are not completely preserved, the median septum, which presumably arched forward, being lost, but the lateral excavation of each cavity is obvious.

The snout is convexly rounded from side to side, $\frac{6}{10}$ inch wide in front, then contracts laterally a little, so as to make the maxillary alveolar border concave, before the jaws widen again in front of the orbits (Plate 1, fig. 1).

There is no certain indication of the limits of the pre-maxillary bones, which are presumed to have contained the incisor teeth. And the maxillary bones are almost as badly defined, although they presumably meet the lachrymal and malar bones behind, in the usual way. The roof of the snout is formed by the nasal bones, which extend from the anterior margin of the orbit forward apparently to the nares, so that as preserved they are about $1\frac{3}{10}$ inch long. They meet the frontal by a transverse suture, which is not very distinct, owing to the condition of the specimen. They

are limited laterally behind by the pre-frontal bones, which form the anterior border of the orbit, extending backward over the frontal bones, upon its superior edge.

The extreme width of the nasal bones in front of the pre-frontal was about $\frac{6}{10}$ inch, and the extreme width between the pre-frontals hardly exceeds $\frac{2}{10}$ inch. The lateral borders of the nasal bones are concave, and the least width in the middle length is $\frac{4}{10}$ inch. They form the back of the nares, and appear to have a lateral squamous extension upon the pre-maxillary bones. The frontal bones meet in the median line in a faint ridge, which makes the superior surface of each longitudinally concave, but this median ridge, which is very slight, does not extend forward on to the nasal bones, and it is terminated behind by the parietal foramen. The length of the frontal bones is about $\frac{7}{10}$ inch. They enter for a short space into the middle part of the upper border of the orbit, which is very slightly reflected upward. The form would be oblong, but that the posterior angles are truncated by the post-frontal bones, which extend outward, backward, and downward to define the back of the orbit, and underlay the frontals anteriorly. The pre-frontal bones overlap the frontals at the anterior corner of the orbit, where their external surface is triangular, and crossed by a longitudinal ridge. This bone is placed at the junction of the frontal and nasal, but laterally it meets the lachrymal bone which is much smaller, and is overlapped by it, so that the lachrymal foramen, which is seen on the inner margin of the orbit, is just below the pre-frontal. The distance of the orbit behind the extremity of the snout, as preserved, is $1\frac{3}{10}$ inch, and the orbits are large, oblique, sub-circular, but somewhat distorted by crushing; not more than $\frac{7}{10}$ inch deep, and about as long. They appear to descend near to the alveolar border, which is prolonged below the orbit as a slender bar, formed presumably of the maxillary bone in front, and the malar bone at the back of the orbit, when it ascends to meet the post-frontal. But owing to the intractable character of the matrix, the details of structure of this slender bar are not well shown on either side. The transverse suture, between the frontal and the parietal, appears to be in front of the parietal foramen, which is small and longitudinally ovate. The brain case is compressed from side to side, and the temporal vacuities appear to have been transversely extended. The sides of the brain case are convex from above downward, and the parietal bone may be overlapped laterally. The width of this region as excavated at the sides of the parietal foramen is $\frac{3}{10}$ inch; but further back it becomes reduced to $\frac{2}{10}$ inch before the occipital plate widens, with the transverse development of what are regarded as the squamosal bones. The squamosal, as it extends outward towards the side of the temporal vacuity, is convexly rounded, and has an appearance of the small quadrate bone being embedded in it, which is not unlike that shown by other Theriodont skulls. But the squamosal appears to rest upon another bone which extends on its inferior margin towards the quadrate region, which is presumably the malar bone. The back of the skull is depressed and imperfect. Its transverse width, as preserved, is about $1\frac{6}{10}$ inch, but was possibly more. The foramen magnum appears to have been above

the articular condyles for the mandible. The occipital condyle is imperfectly preserved, but appears to have been compressed from above downward and transversely ovate. The supra-occipital region inclines obliquely forward, and is marked by a median ridge. The ex-occipital region is prolonged transversely outward, and its suture with the basi-occipital appears to be shown. There is also a transverse suture, which appears to divide the basi-occipital from the basi-sphenoid. The under side of the basi-sphenoid region, as developed, is concave (Plate 1, fig. 2). In advance of the posterior expansion it is greatly compressed from side to side. It is overlapped by a pair of bones which appear to meet in the median line behind, but appear to be separated by a long narrow interspace in front. These bones are regarded as the pterygoids. They measure $\frac{3}{10}$ inch transversely, and the length from the occipital condyle to their anterior border, as preserved, is $\frac{1}{10}$ inch. The pterygoid bones are much wider than the sphenoid which they overlap, and from their posterior angles a narrow vertical bar is directed outward and backward on each side, towards a quadrate region. This encloses a large vacuity on each side of the sphenoid, which is limited posteriorly by the bones at the back of the skull, which extend transversely outward, in the position which corresponds to the opisthotic. This vacuity is subtriangular, about $\frac{9}{20}$ inch long, and quite as wide, on the left side, though on the right side, owing to crushing, the width exceeds the length. On the outer posterior side of this pterygoid bar there appears to be a circular foramen, which I suppose to be homologous with the circular foramen seen in the skull of *Gomphognathus* in the corresponding position, though in that genus the pterygoid bars, which extend outward on each side of the sphenoid, define relatively small triangular shallow concavities. From the front of the pterygoids are given off the transverse bars which are situated below the hinder third of the orbits, and, therefore, are further forward than in *Gomphognathus*. They are imperfectly preserved, but are seen to extend outward and downward by a somewhat expanded surface against the inner side of the lower jaw, and therefore correspond with the bones which I have been led to name the transverse palatine arch in *Gomphognathus* and its allies. The palate then recedes upward as it extends forward, and shows a distinct median ridge, but, owing to the extreme hardness of the matrix, it has not been completely excavated, and the palato-nares are not shown. This difficulty has been augmented by the lower jaw remaining in natural contact with the skull, and consisting of bone which is much softer than the matrix.

The lower jaw shows a relatively wide anterior symphysial region which measures less than half-an-inch transversely; is convex, and recedes from above downward, where the depth of the jaw appears to be rather more than $\frac{3}{10}$ inch at the divergence of the rami. The mandible is about $2\frac{1}{4}$ inches long. It is compressed from side to side, concave on its superior alveolar border, so that the depth of the jaw is less below the molars than it is anteriorly. There is a median longitudinal groove or channel in the middle of the jaw, below the ascending coronoid process, which does not appear to have been conspicuously high. There is an excavation in front of, and

below the articular region, but the hinder part of the mandible is not completely preserved. The inferior border of the dentary bone, which is slightly convex in length, extends back behind the transverse bones. Its superior border as exposed is prolonged in a convex curve backward to the articulation, but there appears to be a thin film of vertical bone below this elevated ridge.

The dentition is not completely displayed, because the jaws are in contact (Plate 1, fig. 3), and the extremity of the snout is lost. There is but little doubt as to the number of the incisor teeth, assuming that the last conical pointed tooth on the snout is not an incisor but a canine. These teeth are remarkable for the absence or shortness of their roots. They are conical pointed, curved, with strong bases; and the crowns are enamelled and show the usual roughness of surface. Three incisors, preserved in the upper jaw, have the crowns about a quarter of an inch long, and the enamel, which is thick, does not extend to the alveolar margin (fig. 4). It is possible that there are four incisors on each side, for there is an interspace on the left side, between the last incisor and the similar canine, which may have carried the tooth, and there is an appearance on the right side of an incisor being hidden by a mandibular tooth at the median line of the jaw.

In the lower jaw there are certainly three incisors, of which the anterior pair is conspicuously larger than the others. They are long, curved teeth, which appear to extend between the maxillary incisors, and the second and third mandibular incisors are placed laterally in contact with each other, and apparently not separated from the fourth tooth, which may be regarded as a canine. I adopt this reading of the teeth, because there is no interspace between the canine and the molars, except such as results from the canine being in an external series, continuous with the incisors; while the molars form a series which is internal in position.

Only five molar teeth can be counted in the maxillary region, on the right side; below them appear to be four, and possibly five, mandibular teeth, of which the three anterior are seen in the external aspect of the jaw, and two appear to be shown behind them on its internal aspect. On the right side only three maxillary teeth have their crowns preserved, but there appear to be indications of two teeth behind them, and in the mandible there are three molars, behind which are indications apparently of two others. These teeth give no evidence of long roots, and it is doubtful whether they possessed any roots at all, since the vertical fractures through the crowns do not show roots; and on the right side the crowns contract towards their enamelled bases, without giving an indication of roots. The crowns are densely placed, so as to be in contact with each other. They do not appreciably contract towards the summit. Each molar of the lower jaw fits between two of the upper jaw, so that they have a somewhat vertically ovate form with apparently a median point. As preserved, the transverse width over the mandibular teeth exceeds that of the maxillary molars. The crowns of the maxillary molars are partially exposed on the left side, within the lower jaw, where they are seen to be transversely wider than

long, tuberculate, and surrounded at the base of each crown by a narrow sharp ridge of enamel. Within this girdle is a number of small rounded tubercles, which appear to differ in arrangement with every tooth, but are more elevated on the external than on the internal border of the tooth. In what appears to be the third molar there is a linear series of seven small cusps on the inner side of the tooth. Within these rise more elevated rounded cusps, which appear to comprise two or three confluent cones. External to these cusps is an outer row of smaller cusps.

In the tooth which follows, the central cusps are less conspicuous. In the third tooth the internal cusps appear to be large. There is no indication that the mandibular molars attained the width of those in the skull; and in all Gomphodonts the mandibular molars, as far as known, are relatively narrow.

Microgomphodon eumerus (Plate 1).

There is a small imperfect skeleton of a Theriodont Reptile which is only inferior in interest to the larger skeleton of *Cynognathus crateronotus*. It was obtained by Dr. R. D. KANNEMEYER from near Burghersdorp. There is some ground for referring it to the Gomphodontia, though the evidence is not conclusive. Dr. KANNEMEYER, in 1892, sent to me some small fragments of jaws with portions of this skeleton, which he thought might all be referred to one individual. Subsequent development of the remains supports this conclusion.

The bones preserved comprise in one small slab (marked E, fig. 8) the left humerus, portions of right and left scapulæ, portion of coracoid, the inter-clavicle and fragment of the clavicle, and portions of ten early dorsal ribs from the left side of the body. The principal slab consists of two parts (marked C and E), which I have fitted together (fig. 6). It shows impressions or the bony substance of fourteen vertebræ and lower dorsal ribs in advance of the acetabulum for the femur. All the pelvic bones are more or less perfectly exposed, as are all the bones of the left hind limb, which shows five digits. The sacral vertebræ are covered by the pelvic bones. There is only an indication of the centrum of one caudal vertebra, behind which are two or three pairs of chevron bones. The fragment marked D (fig. 7) shows the distal ends of ulna and radius, the carpus, and the metacarpal bones of five digits. Besides these remains there is a small fragment in similar matrix, which shows the anterior end of the lower jaw (fig. 5), and has the mandibular and maxillary teeth in natural contact, showing that the animal belonged to the Gomphodontia. There was no possibility of connecting the matrix of this fragment of the skull with the other remains; and therefore, though it may be regarded as associated with them in the absence of any indication to the contrary, the evidence of association is too slender to justify an unreserved reference of the skeleton to the Gomphodont division of the Theriodontia. On the other hand, there is some reason to anticipate from resemblances in skull

structure that the Gomphodont skeleton would be formed substantially on the plan of the Cynodont skeleton, and this fossil shows resemblances in several ways to the skeleton of *Cynognathus*.

Further, the skull fragment (fig. 5) appears to be referable to the genus indicated by the specimen from Aliwal North just described (Plate 1, fig. 1).

The lower dorsal vertebræ in this specimen (fig. 6) are $\frac{4}{10}$ inch long. The corresponding vertebræ of *Cynognathus* are $1\frac{4}{10}$ inch long; so that as the skull in that specimen is more than a foot in the corresponding measurement, it would appear that this small fragment, which is somewhat larger than Mr. BROWN'S skull, is not disproportionate in size to the vertebræ. And, secondly, the head of the femur in this Burghersdorp specimen is $\frac{8}{10}$ inch wide, while the head of the femur in *Cynognathus* is $3\frac{1}{2}$ inches wide. If the head of the femur were proportional to the vertebræ, the anticipated breadth in *Cynognathus* would have been 5 inches; so that, assuming the skull fragment to be referable to this small Burghersdorp skeleton, it indicates an animal with relatively stronger limbs and probably a relatively smaller skull.

The fragment of the jaw is so exposed as to show indications of the teeth in the skull, though no skull bones are preserved, with the exception of the descending transverse and palatine bones, which are seen to abut against the mandible on its inner side. The length of the specimen is about an inch. On the alveolar border seven maxillary teeth are preserved on the right side, and eight apparently on the left side, without indication that the dentition is complete. The first three or four teeth are relatively small, with nearly circular roots; the crowns are convex externally, and appear to be pointed. The posterior four teeth are transversely oblong, or ovate. The last tooth is $\frac{2}{10}$ inch wide, and about $\frac{1}{10}$ inch from front to back. They are closely packed, with scarcely any interspace between them, so that the last four teeth have an antero-posterior extent of little more than $\frac{4}{10}$ inch. Their external surface is convex from front to back, and rounded into the sides. There is a cusp externally, which slightly overlaps the crown of the mandibular tooth beneath, on to which it fits; and although the section of the tooth is not well exposed, the crown was concave from within outward. At the anterior angle, where the canine is usually situate, there is a tooth crown of slender form which appears to be no larger in section than the premolar teeth behind it. It is external in position to the molars, and therefore, I have no doubt that it represents the canine; in front of it are indications of slender incisors.

The fragment of dentary bone preserved on the right side, $1\frac{1}{10}$ inch long, is convex from above downward. The convexity is most marked at the alveolar border and increases from front to back, where the depth of the bone preserved is a quarter of an inch. The jaw is concave in length, and the lower jaw was obviously narrower than the skull, so that its teeth are inclined a little outward, just as the maxillary teeth are inclined downward and inward. The mandibular teeth which may be termed incisors are apparently two in number. There is a small canine, no larger than the

incisors, on the inner side of the front of the maxillary canine. There are three or four mandibular pre-molars, with the crowns broken, which lap on the inner side of the maxillary pre-molars; and behind these are molar teeth with pulp cavities, in which the crowns were opposed to, and fitted against the crowns of the teeth above them. Only the last preserved of these teeth shows that the crown somewhat contracts towards the summit, where it is marked by slight vertical ridges, such as terminate usually in marginal crenulations. There appears to be a strong lateral cusp. On the opposite side nearly the whole of the dentary bone is worn away showing the roots of the molar teeth, which descend almost to the base of the jaw without appreciable decrease in size.

The transverse width of the palate at the hinder molar teeth as preserved is $\frac{7}{10}$ of an inch; and its transverse width behind the canine is $\frac{4}{10}$ of an inch. The alveolar border, both of the maxillary and mandibular teeth, appears to be perfectly straight.

The Vertebral Column (Plate 1, fig. 6)

There is no evidence of the number of vertebræ. The ribs preserved in advance of the articulation of the humerus appear to be eleven in number. Three of the more anterior have only the articular heads preserved. The heads are very large, so that they may be anterior and possibly cervical; which would leave eight to be classed as early dorsal. These ribs are slender, and very imperfectly preserved, so that not more than $1\frac{1}{4}$ inch of the length of any rib is seen. Each appears to be transversely ovate in section, hollow, with a slight longitudinal groove on one side, rather less than $\frac{3}{20}$ inch deep, and about half as thick. Each rib is distinctly curved, and has an expanded head, at the side of which the rib develops a short longitudinal ridge. The neural arch is only partially indicated in the impression of the dorsal vertebræ in the fragment E, which is now united to the slab C. It shows the neural spine to be strong, with the anterior margin inclined, and the summit rounded, with the posterior zygapophysis extending beyond its posterior border. The spines occupy the entire extent, in length, of the neural arch. After the first four or five vertebræ, the column is only exposed upon its ventral surface, which is curved in length, and shows ten centrums in a length of about 4 inches. The earlier centrums seem to be quite $\frac{4}{10}$ inch long; but the length of the column is slightly augmented by its curvature, so that the bodies of the vertebræ are not in every case in close contact. The width of a centrum in front does not appear to exceed a quarter of an inch, but they become slightly wider in the lower dorsal region, where the width is about $\frac{7}{20}$ inch, augmenting to fully $\frac{4}{10}$. The inferior surface of the centrum is rounded from side to side, gently concave from front to back, the articular margins are slightly elevated, and the earlier vertebræ preserved have the sides somewhat compressed, so as almost to produce an infero-lateral ridge. There is some appearance of a slight intercentrum having been present in the first centrum preserved, but

there is no trace of any such ossicle upon the later dorsal vertebræ. No evidence of the tail is preserved, which is sufficiently definite for description. The region covered by the ischiac bones corresponds to the length of two and a half dorsal vertebræ.

The ribs upon this slab are exceptionally interesting on account of the parallel which they offer in character to the ribs of *Cynognathus*, and from the circumstance that in so far as they are preserved the inferior margin of the middle dorsal rib appears to lie upon the intercentral suture, and it is only in the lower dorsal and sacral regions that the rib is articulated laterally on the anterior border of the centrum.

The first rib preserved is slender, and shows no appreciable modification of form, though the anterior border may be little compressed. The second rib preserved is $1\frac{3}{4}$ inch long, strongly curved, compressed laterally in front in the upper third of its length.

The next rib has attained a great transverse width and the head is evidently deep. The transverse expansion is both anterior and posterior, and as though a lozenge-shaped plate were superimposed upon the rib, though the specimen gives no indication of separation between the longitudinal and transverse parts (Plate 1, fig. 6).

The external free portion of the rib becomes shorter, and in the sixth rib preserved it has disappeared. These transverse expansions now assume the aspect of forming a pseudo-sacrum, for, just as the posterior border of the lozenge-shaped plate of the rib overlaps the anterior border of the corresponding plate in the rib behind it in the four ribs in which the rib is produced outward and backward beyond the lozenge, so now the triangular lumbar ribs, if they may be so called, which are five in number, in advance of the two smaller sacral ribs, overlap each other, and gradually decrease in transverse width. The transverse measurement across ribs and vertebra as preserved, at the first of the series is $1\frac{8}{10}$ inch, and the transverse width at the last of the series, which appears partly to support the ilium, is $1\frac{2}{10}$ inch. But the ribs are probably displaced slightly downward, so that their transverse extension may have been slightly greater. Their external margins form a straight line about $2\frac{2}{10}$ inches long on each side, and these lines approximate backward towards the sacrum. The convergence is similar to that seen in *Cynognathus;* but just as in *Microgomphodon* the vertebræ are relatively longer, so the ribs which are not anchylosed to the centrums are relatively more expanded; but the tubercle of the rib which was attached to the transverse process of the neural arch, is developed backward in a similar way. These five ribs, as exposed on the under side, are concave from within outward, with concave margins front and back, with the external expansion conspicuously developed backward in the first, but becoming greatly developed forward in the last, in which there is a distinct inferior ridge on the neck of the rib.

The sacral ribs only differ in their smaller size, and in having the ends more

expanded, so as to give a vertical attachment. The transverse width of the first sacral rib is $\frac{7}{20}$ inch, and the transverse width over the sacrum is $1\frac{1}{20}$ inch.

The internal surface of the ilium, which is exposed and is placed against the sacral ribs, gives no indication of being modified for articulation with sacral ribs. The second sacral rib is only seen upon the right side.

The Pelvis. (Plate 1, fig. 6.)

The pelvis is $2\frac{1}{4}$ inches from front to back as preserved, and the transverse measurement inferiorly appears to have been about an inch or less between the femoral articulations. The iliac bones are imperfectly exposed. But the acetabular surface, like that of the ischium, appears to be large and sub-circular; and these two bones form the greater part of the femoral acetabulum, while the pubis presumably contributed very little, but it has been separated from the slab in removing the matrix, so that it is no longer in natural contact with the associated bones.

The left ilium is crushed a little inward, in close contact with the sacral ribs, with the anterior part of its blade, which is reflected a little outward, lapping along the margin of the last lumbar rib. On the right side, the ilium is displaced a little outward, so as to expose part of its internal surface. The measurement in front of the margin of the acetabulum is about $\frac{9}{10}$ of an inch, and to the posterior limit of that surface about $1\frac{4}{10}$ inch, so that the acetabular border on its flat inner side, which is slightly convex, is half an inch long. The right ilium shows, below the acetabulum and just in front of it, a tubercle almost as stout as the under side of the head of a lumbar rib. It is short, sub-circular, less than $\frac{2}{10}$ inch in diameter, truncated and apparently articular, so that it may be inferred to have given attachment to the pubic bone. There is an indication of a similar tubercle in the same position in the left ilium, though only its fractured base remains. The blade of the ilium is thin: its inferior border is concave, and its superior border, presumably convex, is hidden beneath the lumbar and sacral ribs; and there is no evidence, owing to its being overlapped, whether a posterior process was developed to the blade, as in *Cynognathus*. The bone appears to have been comparatively high, extending apparently at the superior border $\frac{9}{10}$ inch above the lower border of the acetabulum.

The two ischia meet in the median line ventrally, with a slight median overlap. Each bone is $\frac{19}{20}$ inch in extreme length, and $\frac{11}{20}$ inch in extreme breadth. There is an approach to the general form of the bone in *Pliosaurus*. The ventral surface is flattened and the hinder margin convex, so that posteriorly the bones diverge from each other, with a V-shaped interspace. Anteriorly the margin is not quite perfectly preserved; but there is an appreciable notch internal to the acetabulum, which would appear to be part of an obturator foramen, which must have been small compared with that of *Cynognathus*. These ventral surfaces are supposed to have been inclined to each other, though they are now pressed nearly flat, upon the vertebral column.

They are margined externally by a rounded angle, defining the external aspect of the bone, which is more than $\frac{2}{10}$ inch deep. The transverse measurement over the posterior extremities of the ischia is $\frac{9}{10}$ inch. The anterior measurement over the outer margins of their expanded and thickened acetabular ends is $1\frac{6}{10}$ inch as preserved. The transverse measurement over the articular end of each ischium is about half-an-inch.

The pubis gives no certain evidence of being formed of two bones, but it is not entirely free from matrix. It is a thin plate more than $\frac{8}{10}$ inch wide, showing an articular surface at each end. It is apparently convex on the under side, concave on the visceral surface, ossified on the anterior margin, which is transversely concave, and reflected slightly downward in the middle, where there is a small median anterior tubercle. The posterior margin is fractured, and the bone appears to be prolonged backward between the anterior median borders of the ischia, so that the pubis may be inferred to have been relatively longer than in *Cynognathus*. On the left-side a portion appears to be preserved of the acetabular surface behind the articulation with the tubercle on the ilium.

The Hind Limb (Plate 1, fig. 6).

The hind limb is represented on the right side by the head of the femur, which is in contact with the acetabulum. On the left side the femur is entire, with its head in the acetabulum, and exposed upon its infero-posterior aspect. It is about as long as the pelvis, measuring $2\frac{3}{20}$ inches. External to it are the tibia and fibula, the latter not quite perfect. The tibia is $1\frac{17}{20}$ of an inch long. Below these bones are the astragalus and calcaneum; but the other tarsal bones are imperfectly preserved, so that it is impossible to tell whether the scaphoid was present, as it appears to have been in the interspace between the astragalus and first cuneiform, which was of large size, giving attachment to the first digit only. The cavity remains from which the second cuneiform has been lost, and the third cuneiform or cuboid was a large bone, indicated by an ill-defined cavity, which gave attachment to the three external digits. The metatarsals are stout, somewhat larger than the first phalangeal bone. In the first three digits the number of phalanges is apparently three. In the fourth and fifth they are less perfectly exposed, but appear also to number three. The length of the foot from the astragalus to the extremity of the digits is $1\frac{3}{4}$ inch. All the digits are approximately of similar length, so that the foot is short and broad, and measures about an inch from the metatarsal to the extremity of the phalange of the second digit

The Femur (fig. 6).

The femur is a strong bone, with an expanded head, which curves inward and somewhat forward. The head has a transverse width of nearly $\frac{8}{10}$ inch. It consists

of a continuous convex curve, which extends transversely. The inner portion forms the sub-ovate articular head, while the outer half is compressed to a narrow trochanteric ridge; but, owing to the way in which the bone is exposed, there is no evidence whether it is reflected forward at its outer termination, to form a trochanter major on the mammalian plan. The margin of the articular head is prominent owing to a contraction of the shaft immediately below it; but, although this contraction defines the head, it does not constitute a neck to the bone, as in the femur of Mammals and certain Ornithosaurs. The under side of the proximal half of the shaft, towards its inner border, is traversed by the longitudinal trochanter minor. This is a long curved elevated ridge, which commences about $\frac{4}{10}$ inch below the proximal extremity of the bone, and extends down the shaft for about $\frac{3}{4}$ of an inch as a sharp compressed ridge, which is situate exactly in the position of the similar trochanter in the femur of Megalosauroid Saurischia, such as *Palæosaurus*. The effect of this ridge is to make the inner side of the shaft towards its proximal end nearly vertical; and the posterior surface, which is sub-triangular, becomes concave transversely; the curvature of the head of the bone makes it convex in length. A sharp margin appears to define the external border. Externally the femur is slightly sigmoid, because the downward reflection of the distal end corresponds to the upward reflection of the proximal end. The entire width of the bone distally is not completely exposed, but its thickness at the distal condyle is $\frac{4}{10}$ of an inch, and the thickness in the lower half of the shaft is $\frac{1}{4}$ of an inch. Towards the distal end the superior surface is flattened on the inner side, somewhat obliquely, so that the bone is compressed to a narrow rounded ridge just above the condyles. The condyles are not well ossified, or very prominent, leading to the conclusion, also suggested by the separate condition of the lumbar ribs, that the animal was young. The distal articular surface is rounded from front to back and appears to be reniform, with a concavity between the slight condyles on the posterior side.

The Tibia and Fibula (fig. 6).

As already indicated, the femur is longer than five vertebræ, and the tibia is shorter than five vertebræ. The difference of length between the two bones is about $\frac{3}{10}$ of an inch. The tibia is somewhat expanded at both ends, but at the proximal end it is $\frac{1}{2}$ inch wide; at the distal end the width is $\frac{4}{10}$ inch. Its outer, or fibular margin, is perfectly straight, while the inner margin is conspicuously concave. In the middle of the shaft there is a concave ridge, defined by an excavation on the internal side. This ridge dies away both proximally and distally, and, in front, its margin does not rise above the level convex surface of the bone, which has the aspect of being slightly convex from above downward, though this may be the result of *post-mortem* compression which has flattened both ends of the bone. Above the middle the shaft is $\frac{2}{10}$ inch wide, so that the proximal expansion is conspicuous, owing to the

transverse widening being more rapid than the transverse widening of the distal end. The articular ends of the bone are not completely exposed, but appear to be transversely truncated. The fibula is exceedingly slender. It steadily widens from the proximal extremity, where it is thrown a little back towards the outer hinder angle of the head of the tibia, while, distally, its extremity was placed in the same transverse line. The impression from which the bone is broken away at the distal end slightly exceeds $\frac{1}{10}$ inch in diameter. Below the distal extremities of these bones there is an interspace of about $\frac{2}{10}$ inch. Then succeeds the tarsus.

The Tarsus (fig. 6).

This appears to consist of two bones in the proximal row. A large bone on the inner side, with a hemispherical proximal surface, which I have regarded as the astragalus. It is immediately below the tibia. External to it there appears to be a second bone, with a proximal articular surface, which is narrow and elongated from front to back. This bone exposed on its external aspect appears to be nearly equal in the measurements of length and depth. I have regarded it as the calcaneum. But it is not demonstrated that the astragalus articulates with it on the mammalian plan, though it may do so, and the bone does not develop a posterior heel process.

Still, nothing so mammalian has been met with among the Reptiles of the old world. Professor Cope, in his fifth contribution to the Permian fauna ('Am. Phil. Soc.,' 1884), figures a tarsus which is referred to the left foot of *Clepsydrops natalis*, in which there also appears to be a pulley-shaped astragalus with a vertical plate-like calcaneum external to it.

The navicular bone of Professor Cope's figure does not appear to be represented in this fossil, though there is the interspace from which such a cartilage may have been lost. There were certainly three, and apparently four, bones at least in the distal row of the tarsus; but only one of these is preserved, the relatively large, thin sub-quadrate bone which articulates with the first metatarsal. It is about $\frac{1}{4}$ of an inch long, but not quite so wide. The other bones are only known from imperfect impressions which do not admit of description.

The Metatarsus and Digits (fig. 6).

The first digit, measured from the tarsus to the extremity of the claw phalange, is $\frac{19}{20}$ of an inch long. Of this length the metatarsal bone, which is shorter than in the other digits, measures $\frac{3}{10}$ inch. It is broad, wider at the proximal end than at the distal end, with concave lateral margins. The phalanges which succeed appear to be crushed, and are imperfectly preserved. There is no certain evidence of more than three. The first is a short strong bone with a trochlear distal end, and a concave ligament pit is seen on the external margin. This is succeeded by a bone which is imperfect at its distal end, and has much the appearance of a claw phalange as

preserved, but there is another ossification extending beyond it, which, although imperfectly exposed, appears to be the claw terminating the digit.

The second digit is somewhat longer, measuring $1\frac{1}{20}$ inch in length. The second metatarsal is longer than the first, measuring $\frac{4}{10}$ inch in length. As preserved, it extends further proximally, but is narrower and deeper at the proximal end, and wider at the distal end. Its outer side is rather more concave in length than the inner side. The first phalange, $\frac{3}{10}$ inch long, is longer and larger than the first phalange of the first digit. The second phalange appears to be fractured, so that its characters are not very distinct; but the third or claw phalange is blunt, and looks as though its extremity were lost; there is a lateral groove on its outer side. The third and fourth metatarsals have only their distal halves preserved—the third rests upon the inner side of the fourth distally, just as the second rests upon the inner side of the third; and the distal ends of these bones extend successively beyond each other, as though the metatarsals progressively increased in length. The first phalange of the third digit is larger than that of the second, but the first phalange of the fourth digit seems to be smaller. The second phalange is broken, and there appears to be an impression of a claw phalange. The second phalange of the fourth digit is long and slender, and there appears to be a third phalange. The fifth digit is only known from the large metatarsal, which is $\frac{7}{20}$ inch long, though there are some indications of a part of the first phalange. The transverse width over the proximal ends of the metatarsals, as preserved, is $\frac{3}{4}$ of an inch. The digits are nearly parallel to each other, and do not spread, so that the foot has the compact character of the foot of *Dicynodon*, and is so far mammalian. Notwithstanding the slight uncertainty concerning the number of bones in the outermost digit, and the slight imperfections of the specimen, it is important in evidencing for the first time the structure of the foot in association with limbs and a vertebral column, which are shown by their affinity with *Cynognathus* to be Theriodont. Although the tarsus is in some respects less perfectly preserved and less suitable for comparison than that figured by Professor Cope, its resemblance to that type furnishes ground for combining the American and South African animals having such structures, in the same large group.

Clavicular Arch and Shoulder Girdle (Plate 1, fig. 8).

The remains of the shoulder girdle comprise portions of both scapulæ. The coracoid is very imperfectly shown, being partly covered by the interclavicle, which is not in a complete state of preservation, owing to the thin film of bone having scaled off from the rock surface on which it rested. It appears to be $1\frac{6}{10}$ inch long, and about $\frac{4}{10}$ of an inch wide, with sides slightly approximating at the posterior extremity, and slightly widening anteriorly; where a bone, which appears to be the clavicle, rests upon it on the left side.

A longitudinal median rounded elevation extends down the length of the interclavicle; and towards its anterior end there is a radiating series of vascular

impressions. The median extremity of the clavicle is marked with transverse striæ, has a thin edge on the median and inferior border, and a thickened rounded edge on the anterior border, so that in transverse section the bone is somewhat pyriform. It is $\frac{3}{10}$ of an inch from front to back at the extremity, and manifestly has the superior border concave. What appears to be the larger part of the clavicle has been separated by the chisel from the median part of the bone, and the impression, together with the isolated piece handed to me, would appear to give a length to the bone of $1\frac{1}{4}$ inch. If this isolated fragment can be thus identified, it shows a transverse truncated end for articulation with the acromion process of the scapula. In neither case is the scapula entire. The left scapula has lost its posterior extremity, and the right scapula does not show the articular extremity. As preserved the left scapular is $1\frac{7}{10}$ inch long. It is expanded at the articular end, where it unites with a bone which I regard as the pre-coracoid, through which a foramen passes. The suture which I presume to exist between the pre-coracoid and coracoid is not obviously defined, although there is a depression in the specimen which may indicate this suture, and show that the coracoid and pre-coracoid are not co-ossified. The anterior border of the scapula is at first in the same plane with the pre-coracoid, but it is speedily reflected upward to form the acromion; and this upward reflection makes the external surface of the scapula a deep channel, which is concave from side to side, and slightly convex in length with a thin anterior margin, and a thicker rounded posterior margin.

This surface is better seen in the right scapula. Towards the anterior extremity of the left scapula, in front of this upwardly reflected anterior edge, is a sharply compressed ridge, which corresponds with the pre-scapular ridge of *Cynognathus*. It is similarly limited to the free end of the bone, and the measurement from the acromion to the point where it becomes evident, is $\frac{17}{20}$ inch. The width of the blade of the scapula augments from $\frac{3}{10}$ of an inch above the acromion, to about half-an-inch at the transversely truncated extremity. The posterior margin is convex in length, while in *Cynognathus* it is slightly concave, and the anterior margin also appears to be slightly concave.

The Humerus (fig. 8).

The left humerus is well preserved, resting upon the scapular arch, and showing its inferior surface. The head of the bone makes an angle of nearly 45° with the distal end. There is a large deltoid crest extending from the wide proximal end, more than halfway down the length of the bone, reflected downward and outward, and it is this crest which gives the appearance of the ends being twisted at an angle of 45°.

The extreme length of the bone is $2\frac{1}{20}$ inches, so that it is almost as long as the femur, and is equal to the length of five vertebræ. Its inner side is deeply concave, developing a slight short ridge or tubercle, compressed from above downward, just above the distal condyle, and the proximal part of its inner border also appears to be

compressed. A groove, about $\frac{4}{10}$ inch long, which does not appear to be entirely due to crushing, extends from the proximal extremity, parallel to the inner edge. The transverse width of the distal end as exposed, for its external border is not completely uncovered, is $\frac{9}{10}$ inch. The distal condyles appear to be rounded, but they are not well preserved, and above the outer condyle the bone is moderately concave from side to side. On the inner border is the horizontal ent-epicondylar foramen, which passes obliquely inward and downward, under a narrow bridge, which prolongs the radial crest obliquely across the distal end of the bone, and is continued beyond the condyle as a ridge which thickens the distal inner extremity of the bone. The ridge above the foramen is rather more than $\frac{1}{10}$ inch wide, so that it appears to thicken the bone, because it rises above the narrow surface internal to it, as well as above the outer part of the distal end, which has a relatively compressed aspect. The foramen is about $\frac{3}{10}$ inch long, and approaches within about $\frac{7}{20}$ inch of the distal end. The ect-epicondylar foramen is not exposed, owing to the proximity of the external surface of the bone to the scapula. It did not extend quite so far distally as the foramen on the inner side, so far as can be judged from the depression still occupied with matrix, which I suppose to indicate its position. The transverse width of the narrow shaft, measured below the radial crest, is less than $\frac{3}{10}$ inch. The radial crest being developed outward and a little downward, widens the bone, so that the measurement transversely at its termination in the middle length of the bone is about half-an-inch, while the greatest transverse measurement near to the proximal end is $\frac{9}{10}$ inch. The edge is thin, and slightly convex in length; the surface of the proximal end of the bone, which lies between it and the inner margin, is concave transversely, triangular in form, slightly convex in length. The condylar surface at the proximal end is not exposed, but was probably transverse. The proximal border above the condyle is transversely concave; but the external border forms a transversely convex outline, which is continuous with that of the radial crest.

Ulna and Radius (fig. 7).

There is no indication preserved of the ulna and radius, except their distal extremities; but in the slab (fig. 8) there appear to be the scattered bones of the carpus, and at least one metacarpal bone. Fortunately Dr. KANNEMEYER sent me with these remains a small slab marked "D," which shows the distal ends of the radius and ulna, with the carpus, five metacarpals, and indications of phalanges. Of the radius only 1 inch is indicated. It is a strong bone, apparently triangular in section, compressed on the inner side, with a rounded ridge running down the front, and the distal contour rounded internally, and slightly concave at the base, so that it exactly recalls the form of the distal end of the bone in *Theriodesmus*. But the ulnar margin may not have been so well rounded as in that genus. The bone appears to have been hollow, although obscured by crushing.

The distal end of the ulna is less well preserved. What remains shows the bone to have been somewhat less wide than the radius, and that it was flattened, compressed on the radial side, and thickened and rounded on the external side. The bones approach close together at the distal end, but there is a considerable interspace between them, which however diminishes proximally as the ulna widens. The compressed inner plate-like edge of the ulna is perhaps its most distinctive feature.

The Carpus and Metacarpus (fig. 7).

The carpus is in some respects better preserved than the carpus of *Theriodesmus*. It shows three bones in the proximal row as preserved, and there is no reason to expect another bone. Beneath the ulna is a large carpal of vertical reniform shape, which has a flat superior surface, is vertically convex on the external edge, vertically concave on the inner edge, $\frac{4}{10}$ inch high in the vertical measurement, and from $\frac{2}{10}$ to $\frac{3}{10}$ inch wide transversely. This bone appears to extend from the ulna almost to the fifth metacarpal, though its distal border on the inner side appears to have articulated with the carpal bone below it in the second carpal row, which however fitted between this bone and the middle carpal of the proximal row. This is the largest bone in the carpus. I identify it as the pisiform bone.

The middle carpal bone of the proximal row is comparatively small; it is more than $\frac{2}{10}$ inch high vertically, and less than $\frac{3}{20}$ inch wide where it is widest. Its proximal and distal ends are expanded so that it is slightly constricted in the middle. Its external surface is concave, the concavity extending obliquely over it, and being deepest on the side towards the pisiform. It appears to touch the pisiform on both its superior and inferior angles. The external surface of this bone is perfectly preserved; it has not the large number of radiating vascular perforations seen in the pisiform bone. I identify it as the cuneiform. It is not evident that it articulated with the ulna, and would appear to have had its proximal articulation with the inner angle of the pisiform.

The third bone in longitudinal sequence is that which I have termed scapho-lunar, in *Theriodesmus*. It is in close contact with the distal end of the cuneiform. It appears to be an oblong bone, and shows some indication of being possibly formed of two elements; but its external film of bony tissue is imperfectly preserved, so that it is not possible to be certain that a small triangular groove, which appears to be present on the inner border, indicates separate ossifications. And although I have developed the specimen so as to search for a possible ossified external surface, I am unable to recognise either such a surface, or evidence for the sub-division of the scapho-lunar bone. The scapho-lunar appears to be sub-quadrate in form, wider than high; the transverse measurement is $\frac{3}{10}$ inch; the vertical measurement $\frac{2}{10}$. The superior border is concave, and the bone appears to extend inward beyond the radius, though it probably extends backward, and has been displaced forward by

the compression of the carpus. Its superior surface is concave, corresponding to the form of the distal end of the radius. Its inferior border is transversely straight, and the internal border is curved. This bone rests upon a hard mass, which extends transversely inward from the tarsus, but does not present any character by which I can recognise it as bone.

Below this scapho-lunar is a central bone, slightly displaced forward, so that its oblong form is distinctly seen, with proximal and distal surfaces. It is less than $\frac{2}{10}$ inch long, and fully $\frac{1}{10}$ inch deep; convex on the superior surface, and cartilaginous on the internal surface. It is probable that there is a second central bone, and possibly a third; but the second, although indicated by an interspace, does not appear to be ossified so completely as the first, and therefore its existence can only be regarded as probable. If the third central element exists, it may be blended with the fourth carpal of the distal row. But only the first central bone can be regarded as demonstrated by the specimen. There is no indication of any pre-pollex having been attached to it; and although there is a hard mass of sub-quadrate form, $\frac{4}{10}$ inch wide, and $\frac{1}{2}$ inch deep, which may possibly have been cartilaginous, extending internal to the carpus, it is unlike any structure that might be expected to be developed in such a position as a part of the carpal region.

The distal row of the carpus consists of four large bones. The evidence is not clear that there is a minute fifth; but there is a slight impression exposed beyond the fourth, which may indicate a minute ossification.* The first bone which is regarded as the trapezium is placed below the central bone with which it articulates; and it terminates in an oblique surface on the inner margin of the foot, to which surface the first metacarpal bone was articulated. The bone is smooth, oblong, wider than deep, deeper than the trapezoid, so that its distal extremity has a small articulation with the second metacarpal as in the human carpus.

The second bone of the distal row of the carpus is small, deeper than wide, articulates proximally with the central bone, and distally with the second metacarpal.

The third bone of the distal row of the carpus, which is identified as the magnum, has the aspect of having been ossified only in its proximal half, and is presumed to have articulated proximally with the second centrale; while distally there appears to be an interspace between the well ossified part of the bone and the third metatarsal, which may not be produced by displacement.

The ossified part of the os magnum is a little wider than the trapezoid but not quite so deep.

The fourth bone or unciform fits into the angle between the cuneiform and pisiform. Its unossified distal end, if rightly interpreted, gave attachment distally to the fourth metacarpal and externally to one half of the head of the fifth metacarpal, between

* Compare the distal row of the carpus of *Mesosaurus* ('Quart. Jour. Geol. Soc.,' vol. 48, Plate 18), in which four bones correspond to the first four digits; but neither the pisiform bone, nor the fifth of the distal row is shown.

which and the pisiform is the possible representative of a minute fifth bone in the distal row of the carpus. All the bones of the distal row are in close contact with each other, as are the bones of the proximal row; and it is on this account, as there is no evidence of vertical displacement, that I am disposed to regard the interspaces as indicative of areas which were cartilaginous during life. The transverse width of the carpus in the proximal row is about $\frac{13}{20}$ of an inch, but the transverse measurement over the four bones of the distal row is only a little more than half-an-inch, and the transverse measurement over the proximal ends of the five metacarpals is about $\frac{7}{10}$ inch.

The metacarpal bones progressively elongate from the first to the fourth; but the fifth appears to be a little shorter. The bones are short and strong; the first is stout, $\frac{3}{10}$ inch long, nearly $\frac{2}{10}$ inch wide, and equally wide at the proximal and distal ends. The second, third, and fourth bones are much wider distally than proximally; and the transverse width of the middle part of the bone diminishes to the fourth, which is nearly half-an-inch long. The proximal end of the fifth metacarpal again becomes wide, and its extremity is convex, so as to present superior and lateral faces for articulation.

The only phalanges indicated are a portion of a small phalange attached to the first metacarpal and the strong, broad, nearly perfect first phalange attached to the second metacarpal, which, as preserved, is $\frac{3}{10}$ inch long, and rather stouter than the metacarpal bone. The metacarpal bones radiate, and, since they progressively elongate, the digits may have elongated from the first to the fourth or fifth.

III. Trirachodon (Plate 2).

The genus *Trirachodon* is founded upon four skulls, of which the best preserved (named *T. Kannemeyeri*) was obtained by Dr. R. D. Kannemeyer, near Burghersdorp, and presented by him to the Albany Museum, Grahamstown (Plate 2, figs. 1 to 4). This specimen has the lower jaw in contact with the skull. The other three specimens, which are less perfect, but also less distorted, all show the palate and its dentition more or less completely. Two specimens were collected by Mr. Alfred Brown at Aliwal North. Dr. James Berry, of Queenstown, found the fourth (Plate 2, fig. 9) at Lady Frere. I am unable to distinguish specifically between the specimens obtained by Dr. Kannemeyer and Mr. Brown, unless the number of molars establishes a difference; but it seems probable that the somewhat larger specimen with smaller teeth, from Lady Frere, belongs to a different species.

The skull in this genus has a remarkably mammalian aspect, in form and proportion of every part. It was 4 inches long, as preserved, and about 2 inches wide behind. The orbits are circular; placed slightly in advance of the middle length of the head. The snout appears to have terminated conically, rounded above and tapering forward, with a rounded alveolar margin, which is imperfectly preserved. The nasal septum, if it ever existed, is lost.

In Mr. BROWN'S specimens (figs. 5 and 6) the canine tooth does not appear to have appreciably inflated or widened the jaw. The incisor teeth are imperfectly indicated. Four are counted on the left side in the Aliwal specimen, numbered 8 (fig. 5), but they were probably more numerous. The incisors of the upper jaw appear to be lost with the extremity of the snout in the Burghersdorp fossil (figs. 1–4). It is difficult to distinguish the exact number of teeth indicated in the fracture. Three appear to be exposed or indicated, so that eight may probably be the total number of incisors. These teeth have long roots and conical crowns; but no specimen is so exposed as to give evidence whether the lateral margin of the tooth was serrated, as was probably the condition. A considerable diastema appears to have separated the incisors in the Burghersdorp fossil (figs. 1, 3, 4) from the canine. The length of the space is about $\frac{7}{20}$ inch. The canine tooth differs from that of other genera in being marked by parallel blunt ridges (figs. 1, 3), which extend down its length so as to give the side of the tooth an angulated aspect. Two teeth of similar character, collected by Dr. KANNEMEYER from Wonderboom, and described in Section 3 of this paper (IX.), for the opportunity of examining which I am indebted to the Trustees of the South African Museum, Cape Town, show the same character, only those teeth appear to be more slender, and the fluting in them is also developed by two similar ridges on the inner side of each tooth, which correspond to the external ridges. The anterior border is convex, the posterior border is concave. The anterior border is rounded, the posterior border in the Burghersdorp specimen is sharp. Both canines are broken short, but the posterior border is distinctly serrated. On the left side there is a tooth adjoining the anterior margin of the canine, which is pointed, spear-like, short, and serrated on its anterior border. It has the aspect of being an accessory canine, or a canine which has not been absorbed. There is no indication of a tooth in this position on the right side of the jaw. The transverse width of the base of the canine tooth is $\frac{1}{4}$ inch. These teeth appear to be placed just in advance of the divarication of the rami of the mandible, behind the symphysis.

The molar teeth have short low crowns, and, as exposed laterally on the left side, nine are counted, which extend to the limit of the alveolar margin, showing rounded somewhat inflated conical crowns, of which the palatal grinding surfaces are necessarily hidden. In a specimen which appears, from the unworn state of the molars, to be young, belonging to Mr. ALFRED BROWN, and by him numbered 19, there are six maxillary teeth preserved, with indication of the roots of two other teeth in advance of these, so that the number shown does not exceed eight (fig. 7); yet, as the last of these is only partially cut, and there is a small space behind it, it is not impossible that the jaw may have included nine teeth, of which not more than the first two, which are lost, could be reckoned as pre-molars. The pre-molars had small flattened crowns, and in the Aliwal specimen, No. 8, there is some appearance of the first pre-molar, which is small, being elongated from front to back, and surrounded by a coronet of small rounded cusps, as in

Microlestes, while, in the second pre-molar on the right side, the crown appears to be more circular, with the cusps developed more on the plan of *Diademodon*. The molars are closely packed, without any interspaces between the crowns, which are but moderately elevated above the alveolar border, and the right and left series diverge a little as they extend backward. But, owing to the teeth widening transversely in posterior sequence, there is little increase in the width of the hard palate, behind which at least two teeth may be considered to extend, on a plan which, among existing animals, is essentially marsupial.

Each molar crown (fig. 8) has three conspicuous transverse ridges, but the middle ridge is the most elevated, and rises into a distinct cusp on the external and on the internal margins. In the anterior teeth the enamel of this ridge is probably somewhat worn on the inner side, for the ridge appears to be doubled. On the anterior and posterior edges there are limiting ridges to the upper surface of the crown, which are less elevated, slightly crenulate, and continuous with the lateral cutting edges or cusps of the teeth. In the Burghersdorp skull (fig. 1) the last two molars appear to be slightly wider than the others, and less convex on their lateral surface. They are only exposed on the left side. In the Aliwal specimen, No. 17 (fig. 7) six molar teeth are contained in the length of $\frac{3}{4}$ inch. The width of the posterior molars is about $\frac{3}{10}$ inch, though the last tooth is somewhat narrower, and the first molar preserved is $\frac{2}{10}$ inch wide.

The transverse measurement over the palate and the hindermost molar teeth in this specimen is about $1\frac{1}{10}$ inch, and over the first molar teeth it is about $\frac{13}{20}$ inch. The breadth of the palatal interspace between the anterior molar teeth is $\frac{3}{10}$ inch, but behind the hard palate the teeth diverge, so that the breadth between the penultimate molars is $\frac{9}{20}$ inch. The molar teeth, seen laterally, show a markedly convex contour from front to back, as in many Rodents, Elephants, and other Mammals. In the second Aliwal skull, the lateral ridges of the teeth appear to be worn down, as though the movement of the jaws had been transverse; though it is difficult from the overlapping of the canines to suppose any such movement possible. In both specimens the palate is badly preserved; but there is a median suture between the maxillary bones, and some evidence that the hinder part of the hard palate was formed by the palatine bones, which help also to make the lateral walls of the posterior nares, which are divided by a thin vertical plate, regarded as vomerine. The palatine bones are flanked laterally by the descending palatal plates; which are imperfectly preserved, and probably consisted of the transverse bones. The base of the brain-case is imperfectly displayed, and the pterygoid bones are not exposed as in allied genera.

The height from the basi-sphenoid to the summit of the parietal crest at the posterior fracture of the brain-case (fig. 6) is $\frac{17}{20}$ inch. The wall of the brain-case is thin, and the crest above it is narrow. The vacuity for the brain, which is partly exposed, appears to be vertically ovate or sub-triangular. Seen from above, the skull has the aspect of consisting of the conical rounded snout, limited posteriorly by the

circular lateral orbits, and the post-orbital region, which comprises the temporal vacuities, defined from each other by the slender straight parietal crest, about $1\frac{7}{20}$ inch long, and margined externally by the somewhat deep malar arch (figs. 1 and 6), which has its posterior superior margin slightly reflected outward. The orbits appear to look outward, and a little forward and upward. They are apparently rather deeper than wide, being $\frac{7}{10}$ inch high and $\frac{6}{10}$ inch from front to back, bordered superiorly by the post-frontal bones, which abut internally against the frontal bones, which meet in a slightly raised median suture; and each post-frontal sends a slender bar backward. These bars converge to form part of the parietal crest. The post-frontal bone extends outward as a bar, less than $\frac{2}{10}$ inch wide, with the angles rounded in front, and the posterior margin slightly raised; and this transverse bar is bent a little backward and downward behind the orbit, to meet the malar bone, which contributes the larger and inferior part of the zygoma. The transverse width of the post-frontal, as exposed, is about $\frac{6}{10}$ inch. It appears to extend downward behind the malar bone, to the base of the orbit.

The length of the inner border of the post-frontal, which abuts against the frontal bone, is 1 inch. The transverse width between the orbits as preserved in the distorted skulls is about $\frac{8}{10}$ inch. The post-frontal bone overlaps the pre-frontal, which forms the anterior border of the orbit, and is placed above the lachrymal.

The sutures are distinct which separate the pre-frontal and post-frontal from the frontal bones. Both pre-frontal and post-frontal are exposed on the inner superior surface of the orbit.

The inferior border of the lachrymal bone is imperfectly shown in all the specimens; but it appears to be triangular, broad above, and narrower below. It meets the pre-frontal and nasal above, and the maxillary bone in front. The evidence of a lachrymal foramen in the bone is not clear, though its orbital border is excavated, and the foramen may be present in the depression.

The maxillary bones are large, and extend back below the orbit, where a descending tubercle of the malar bone is developed, similar to that seen in many Marsupials. The bones are traversed along the region of the molar teeth by a strong rounded blunt ridge, which divides the external surface into an inferior part inclined downward to the teeth, and a superior part inclined upward to the nasal bones. This ascending plate of the maxillary bone has a convex lateral contour, the superior borders approximating, so that there is only a transverse breadth of $\frac{7}{20}$ inch of the convex middle part of the nasal bones exposed between the maxillary bones.

The length of the maxillary bone is about 2 inches, but it is not quite complete in any specimen, and its depth behind the canine tooth is about $\frac{9}{10}$ inch. The bone does not enter into the anterior nares, though it extends almost to the nasal border by squamous overlap of the pre-maxillary.

The nasal bones form the entire roof of the snout, in advance of the anterior border of the orbit. The frontal bones impress them, so that their posterior contour is

concave. The suture between them is distinct down its entire length. The lateral contour is concavely constricted, partly owing to a slight maxillary compression where the bones ascend highest, but mainly owing to the manner in which those bones encroach upon the nasal bones by squamous overlap. The width of the nasal bones in front, just behind the anterior nares, is $\frac{13}{20}$ inch, and the width of the nasal bones at their junction with the lachrymal is about $\frac{3}{4}$ inch, or rather more. The exact form for the nasal aperture cannot be given. It shows but one transverse terminal cavity. This may be the result of loss of a pre-maxillary septum, which divided the nares, and gave them a lateral instead of a terminal position, or it may result from the pre-maxillary not meeting the nasal bones. The superior contour of the nasal bones from behind forward is convex, and favours the hypothesis that the convexity was further prolonged forward, in the way seen in some other Theriodont skulls, like *Cynognathus* and *Gomphognathas*.

The superior surface of the frontal bones is concave in all specimens, with a median ridge dividing the slight concavity into lateral parts. This surface is $\frac{3}{4}$ inch long, and widens anteriorly to nearly $\frac{1}{2}$ inch at the junction of the pre-frontal with the post-frontal bones. The back of the skull, seen from above, is occupied almost entirely by the large temporal vacuities which are defined externally by the malar arch, parallel to the narrow parietal crest. The post-frontal bones in front are nearly parallel to the diverging V-shaped sides of the occipital plate behind. The width of each vacuity is about $\frac{7}{10}$ inch, and its length from the rounded anterior post-frontal border to the angular bend in the squamosal bone posteriorly, which is above the auditory groove on the border of the occipital plate, is about 2 inches.

The parietal foramen is not distinctly marked; and this may be a consequence of the lateral development backward of the post-frontal bones, which form the anterior part of the parietal crest; there is a doubtful indication of a small foramen at the point where the parietal crest becomes thinnest, which I suppose to be the junction of the parietal and frontal bones.

The external boundary of the temporal vacuity is made by the malar bone in front, and the squamosal bone above and behind. The latter bone is continued on the inner side of the occipital plate towards the parietal crest. The zygomatic arch, which the malar and squamosal bones form, is about $\frac{7}{10}$ inch deep in the middle. Its contour is convex above, concave below, and convex in length. It is about $1\frac{1}{2}$ inch long, forming a thin plate which prolongs the widened contour of the skull from the base of the orbit backward, so as to form a convex surface behind the articulation for the mandible. The malar bone which forms the base of the orbit posteriorly, gives off an ascending process, which unites with the post-frontal bone to make the post-orbital bar. It makes the anterior and inferior part of the zygoma, just as the squamosal bone makes its superior and posterior part. The superior edge of the squamosal does not extend as far forward as the post-orbital bar, and the depth of this plate decreases as it extends forward. Its hinder margin is reflected outward,

so as to make a distinct notch at the back of the temporal fossa. Its posterior surface is vertical, or nearly so. At its base is the articular condyle for the lower jaw, but the suture cannot be distinctly traced which separates what appears to be the squamosal part of the articulation from what is regarded as the quadrate part. The occipital plate is not completely exposed, owing to some of the vertebræ being in contact, but it shows a concave area above the foramen magnum, margined laterally by the ascending occipital crest, which has a mammalian appearance.

The lower jaw is remarkable, first, for the complete blending of the rami, secondly, for the compressed mammal-like form, with the prominent angle to the jaw, and an ascending coronoid process of large size; but although the dentary bone is thus developed so as to be almost coincident with the extent of the mammalian mandible, it stops short $\frac{2}{10}$ or $\frac{3}{10}$ inch from the mandibular articulation, into which it does not enter. The articular bone which occupies the position of the Meckelian cartilage, passes backward behind the dentary, at some height above the angle of the jaw, so as to make the articulation with the skull in the same way as in existing Reptiles.

Received, November 12, 1894.

Trirachodon Berryi. (Plate 2, fig. 9).

The anterior part of the small skull from Lady Frere, collected by Dr. JAMES BERRY, has already been figured in comparison with the skull of *Tritylodon* (see Section 2 of Part IX.), so as to show its superior aspect. It is a little depressed by crushing, and the palate, as in so many similar examples, has become slightly narrowed by the palatal plates of the maxillary and palatine bones having slipped over each other at the median suture. The specimen, as preserved, is about 3 inches long, and was probably somewhat larger than the skull from Burghersdorp, now described as *T. Kannemeyeri.* Making all allowance for the effect of vertical crushing, it appears to differ from that species, first in a more expanded form of the snout than is shown in the uncrushed specimen from Aliwal North (Plate 2, fig. 5), and, secondly, the molar teeth are much narrower transversely and more numerous (Plate 2, fig. 9). It gives no evidence of division of the nares by a median partition, in this respect appearing to resemble *Tritylodon.* But it does not give conclusive evidence that the median partition did not exist. On the contrary, there is an impression left, where the anterior part of the nasal bones is lost from the hinder border of the nares, which suggests that, if not divided by a median partition, they may have approximated to the form of a figure 8 placed transversely. This skull is the only example of the generic type in which the pre-maxillary border is so far preserved as to indicate the number of the incisor teeth, which are all broken off transversely, at or below the bases of the crown. The pre-maxillary bones are slightly separated from each other in front, in consequence of vertical pressure, so that on the right side, in which the alveolar border shows no conspicuous abrasion, the roots of three incisor teeth are visible, more or less circular in transverse section,

and the third tooth is somewhat larger than the other two. On the left side the alveolar border is slightly broken. The first two incisors are distinct in their close set sockets, and the third, which was external to the narine, is less well preserved. There is no reason to suppose that there were more than three incisors, which are arranged in a curve extending backward.

There is a slight groove which extends longitudinally backward on the palate between the first and second incisors; and behind and on the outer side of the third incisor there is a large deep longitudinally ovate pit, which excavates the roof of the palate, and presumably received the mandibular canine, on each side. The pit is situate internal to and in front of the maxillary canine, and approaches close to the alveolar border, so that there appears to have been a considerable diastema between the outermost incisor and the canine tooth in the upper jaw, where this interval measures about $\frac{1}{4}$ inch, while the transverse width over the six incisors is about $\frac{3}{4}$ inch.

The canine teeth are broken away, so that only the oval bases of the crowns remain, and these are directed forward and outward, causing a bulbous inflation of the snout, of the kind seen in *Gomphognathus*, which is due partly to the upward and backward direction of the large canine root, and partly to the outward inclination of its anterior margin. The length of the base of the crown on the alveolar border slightly exceeds $\frac{3}{10}$ inch, its width is $\frac{2}{10}$ inch. Its external surface appears to be longitudinally striated and furrowed. The least transverse width between the hinder borders of these teeth, as preserved, is $\frac{3}{4}$ inch, and was originally slightly less, since the inter-dentary part of the palate is a little widened in front and contracted behind by *post mortem* displacement. The external width of the snout over the roots of the canines is $1\frac{3}{10}$ inch. Then there is a pre-orbital contraction which forms a lateral concavity behind the root of the canine tooth, in front of which the pre-maxillary suture appears to ascend. Inferiorly the maxillary bones are convex, and the alveolar borders approximate somewhat behind the canines. The transverse width over the palate between the first pre-molar teeth is nearly $\frac{7}{10}$ inch. The interspace between this pre-molar tooth and the canine on each side measures about $\frac{2}{10}$ inch.

The molar teeth are at first extremely small, being smaller than the canines; and they appear to be circular, becoming transversely ovate. They have the crowns relatively high. On the right side eleven appear to be evidenced, but the tenth is only represented by an interspace from which the crown is lost. The length of this series of teeth is $1\frac{1}{10}$ inch. The greatest width of each of the molars, where they are widest, at the back of the hard palate, is less than $\frac{1}{4}$ inch, though more than $\frac{2}{10}$ inch. Eleven teeth are also counted on the left side. The crowns appear to be a little higher than in *Trirachodon Kannemeyeri*. The series is convex from front to back and the anterior teeth are largely worn with use, so that the longitudinal transverse ridges which originally crossed them, are almost obliterated. In the seventh, eighth, and ninth teeth of the right side, these ridges are more or less well preserved. The anterior and posterior ridges are small and crenulate, and the median ridge is high.

The crowns are in the closest possible contact. The last tooth is preceptibly smaller than the ninth. It shows a strong cusp at the inner hinder angle, a central cusp and a girdle of small cusps, so that, as the tooth is only slightly wider than long, it resembles the crown in some of the anterior teeth of *Diademodon*. The distance of the hindermost tooth from the anterior border of the socket of the first incisor slightly exceeds 2 inches. The transverse width over the hindermost molars and the intervening palate slightly exceeds $1\frac{3}{20}$ inch.

The length of the hard palate is about $1\frac{6}{10}$ inch. Each half of the palate behind the pre-maxillary suture is longitudinally concave; its outer border descends to form part of the sockets for the teeth. Behind the transverse maxillary suture, which is about opposite the fifth tooth, the palate is formed by a horizontal plate of the palatine bone, which is continued backward and upward, and forms the floor of the palato-nares. The measurement of this trapezoidal nasal area is about an inch in length by an inch in width posteriorly, and half-an-inch anteriorly, at the transverse termination of the hard palate. It is excavated in the usual way by a median longitudinal channel which narrows posteriorly, flanked on each side on its hinder part by a lateral channel; and these channels approximate towards each other behind. They excavate the anterior faces of the transverse arch which descends below the palate, but is here broken away. Its transverse width at the fracture is one inch, and the base of the fracture is $2\frac{6}{10}$ inch behind the first incisor tooth.

On the upper surface of the skull the anterior nares have a width not exceeding $\frac{6}{10}$ inch. Behind them are the nasal bones, which are long, measuring apparently $1\frac{6}{10}$ inch in the median line, to the frontals. They are contracted in their median length, by the overlap of the ascending convex borders of the maxillary bones, to a width of half-an-inch, but they expand in front and behind to about $\frac{8}{10}$ inch. The posterior suture, with the frontal bone, is transversely sagittate, and is situate above the anterior border of the orbit. The anterior extremities of the nasal bones are not preserved. The frontal bones are divided by a median suture, which forms an elevated median ridge, as in the other species of the genus, so that each frontal is longitudinally concave. The bones narrow posteriorly to a point which lies between the anterior parts of the temporal vacuities. This wedge-shaped configuration results from the manner in which the post-frontal bones are superimposed upon the frontals as elevated bars, which extend transversely outward, so as to define the orbits from the temporal vacuities. The post-frontal has its posterior margin slightly elevated and concave, and its anterior margin rounded and directed outward and backward. The suture which defines its junction with the pre-frontal is not quite clear on the superior border, though an elevated ridge extends forward from the anterior margin of the post-frontal, which appears to coincide with its boundary. But, within the orbit, the suture which limits the post-frontal bone is distinct, and the bone, which is regarded as pre-frontal, is fairly well defined as forming the superior margin of the orbit, and meeting the lachrymal bone in front.

The lachrymal is wedged in between the maxillary nasal and pre-frontal bones, and appears to be penetrated by a small lachrymal foramen within the orbital border, but the foramen is not distinctly preserved. Externally the lachrymal bone is triangular.

The maxillary bone, as preserved, joins the pre-maxillary by a suture which extends upward and backward. It appears to be in advance of the canine tooth, but, as in many of these animals, there is some uncertainty as to whether a bony scale does not overlap the pre-maxillary suture along this line. The external aspect of the maxillary bone is chiefly remarkable for the strength of the external process which forms the floor of the orbit, which is seen (Plate 2, fig. 9) to extend transversely outward, enormously augmenting the width of the skull at the orbits, making the bone convex and prominent external to the molar teeth. But the ascending process of the maxillary bone is distinctly concave.

Explanation of Plates.

PLATE 1.

Microgomphodon.

Fig. 1. Skull of *Microgomphodon oligocynus*, seen from above, showing the nasal, maxillary, frontal, pre-frontal, and malar regions, with the orbits, and temporal vacuities. It is somewhat distorted. Found by Mr. Alfred Brown, near Aliwal North.

Fig. 2. The same skull, seen from the palatal aspect, showing the basi-sphenoid region, pterygoid bones, lower jaw, and posterior palatal vacuities.

Fig. 3. Right side of the same skull, showing the contour of the head, and anterior part of the lower jaw, with the teeth, orbit, &c.

Fig. 4. Left side of the same skull, twice natural size, showing the pre-molar and canine teeth.

There is no evidence that this skull belongs to the same species as the other remains figured on the plate, which were collected by Dr. Kannemeyer, near Burghersdorp.

Fig. 5. Fragment of skull, showing part of the lower jaw and upper and lower molar teeth. *Microgomphodon eumerus.*

Fig. 6. Thoracic part of skeleton, showing ventral aspect of the hinder part of the vertebral column, the pelvis, and hind limb. The pubic bones are not now in natural contact with the other elements of the pelvis, but are drawn in the position which they are believed to have occupied.

Fig. 7. Bones of the anterior extremity, including parts of the ulna and radius, the carpus and metacarpus, of the same specimen.

Fig. 8. The humerus, scapular arch, and ribs of the same animal.

All the figures on this plate are of natural size, except fig. 4.

PLATE 2.

Trirachodon Kannemeyeri (figs. 1–8).

All these figures are of natural size, except fig. 8, which is enlarged three times.

Fig. 1. Left side of the skull, showing the lower jaw in contact, with its coronoid process passing beneath the malar arch.

Fig. 2. Same skull, seen from above, showing the elongated temporal vacuities and the posterior notch in the occipital plate.

Fig. 3. Right side of the skull, with the malar arch broken away, showing the coronoid process of the dentary bone of the lower jaw, the parietal crest, orbit, and teeth.

Fig. 4. Inferior aspect of the anterior part of the same skull, showing the symphysial region of the mandible fitting between the canine teeth in the skull.

Fig. 5. Anterior superior aspect of a specimen of the same genus found by Mr. ALFRED BROWN at Aliwal North, which shows the rounded contour of the pre-orbital region of the skull, as well as the sutures between the cranial bones.

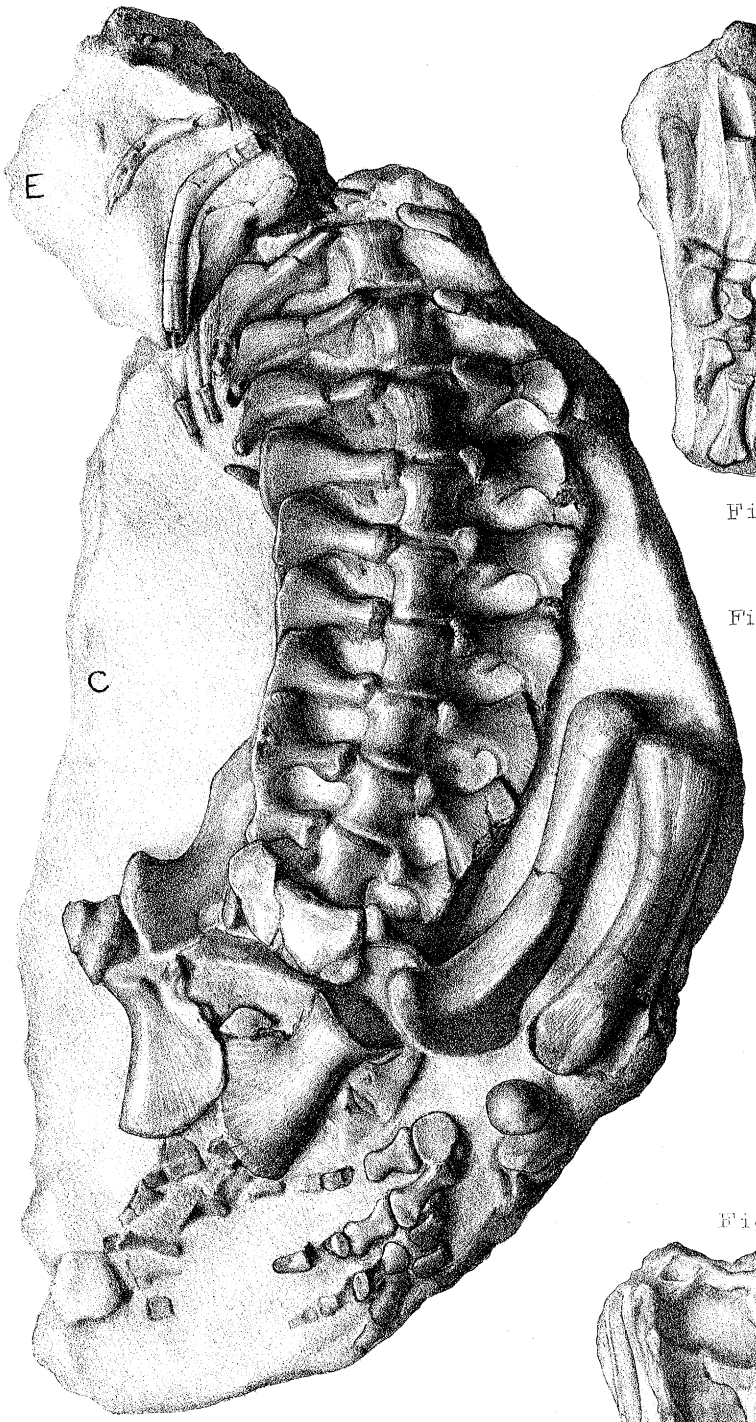
Fig. 6. Superior aspect of another skull from Aliwal North, found by Mr. ALFRED BROWN, which shows the orbit and greater part of the temporal vacuities. It may be compared with fig. 2.

Fig. 7. Palatal aspect of the same skull, showing the transversely expanded molar teeth, and a part of the vault of the palato-nares.

Fig. 8. The molar teeth of the left side enlarged three times to show the details of the three transverse ridges, and crenulation of the crown.

Trirachodon Berryi.

Fig. 9. Palatal aspect of a skull found by Dr. JAMES BERRY, of Queenstown. Its specific difference from the other skulls is shown in the narrower crowns, but the teeth are worn down with use, so that identity of structure with the crowns shown in fig. 8 is only indicated in the hinder teeth.



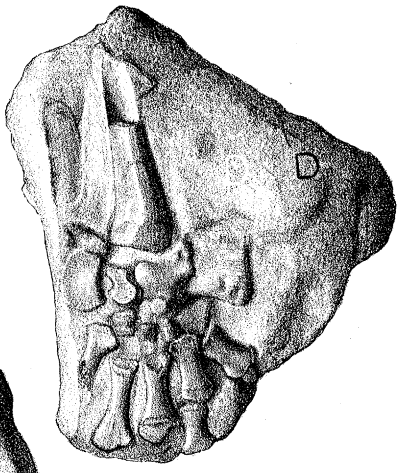


Fig. 7.

Fig. 5.

Fig. 4.

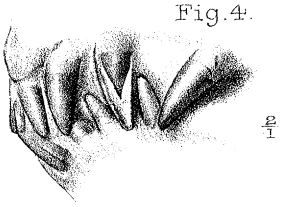


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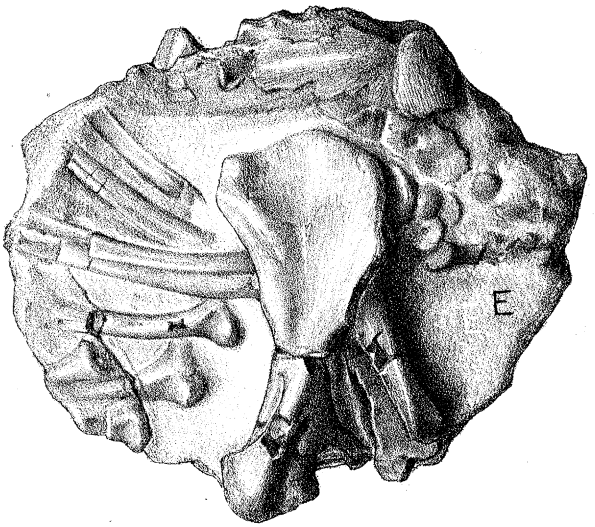
Fig. 6.

Fig. 8.



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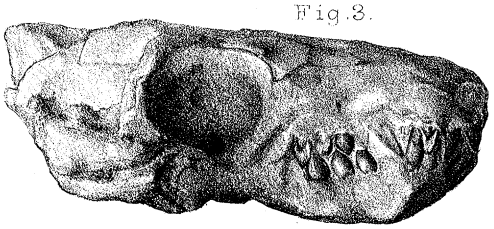

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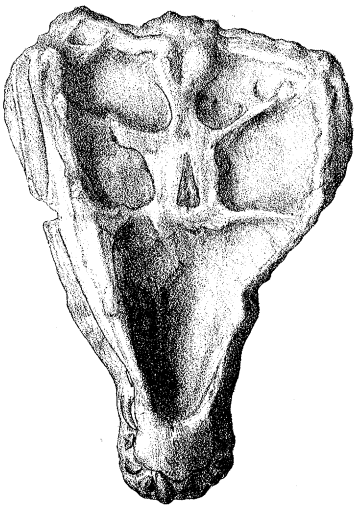
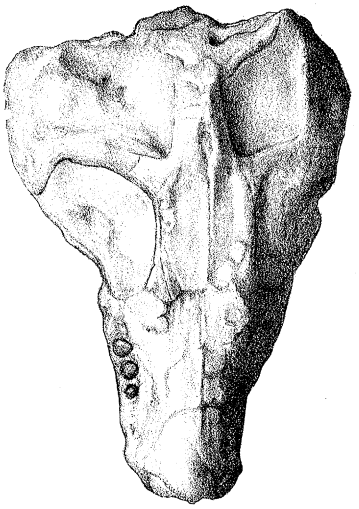


Fig. 1.

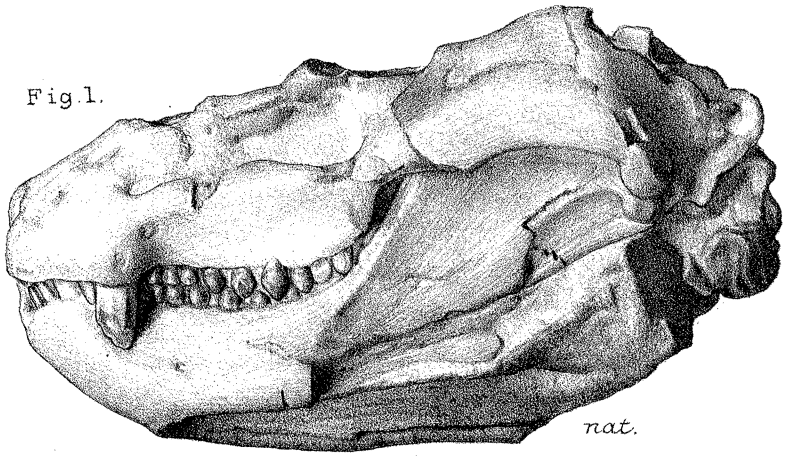


G.M. Woodward del. et lith.

West, Newman imp.

Microgomphodon.

Fig. 1.



nat.

Fig. 8.

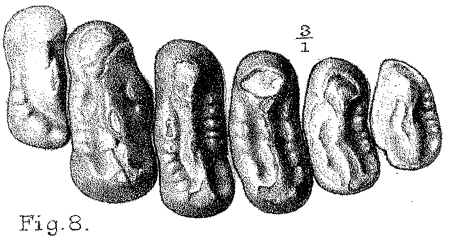
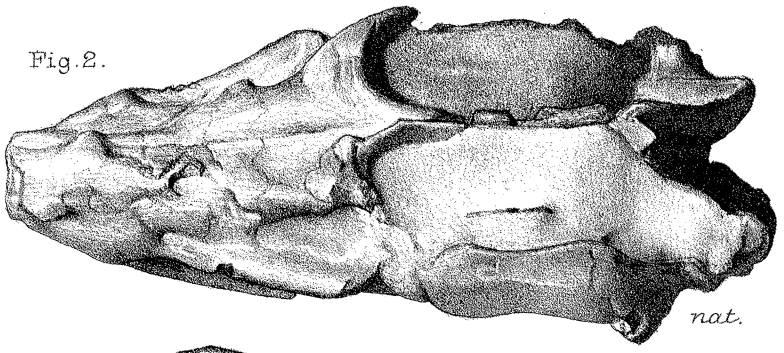


Fig. 2.



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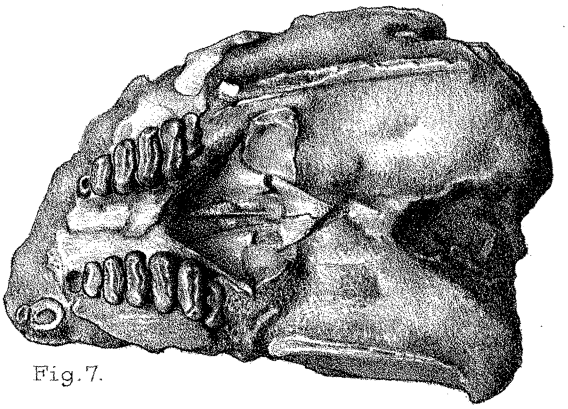

Fig. 6.

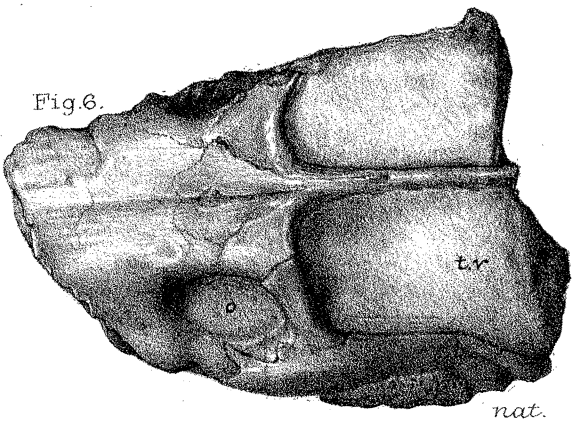

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Fig. 3.

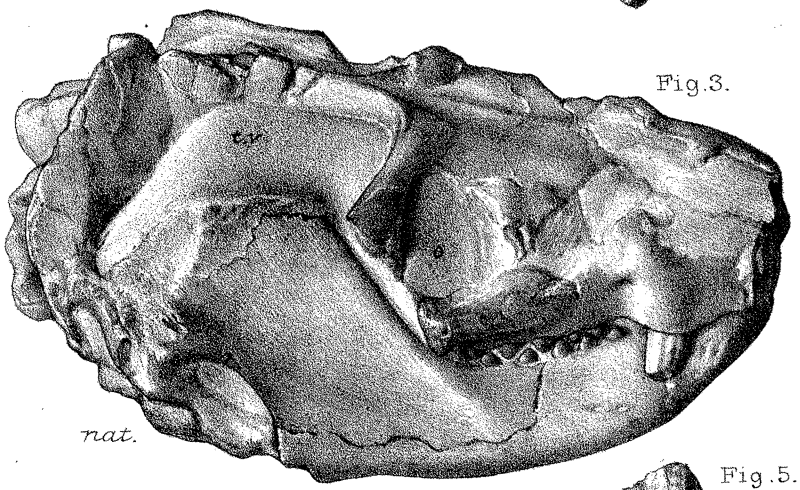

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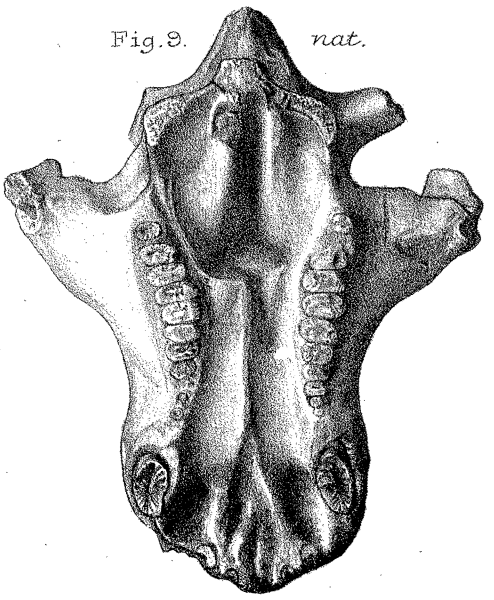
Fig. 9. *nat.*



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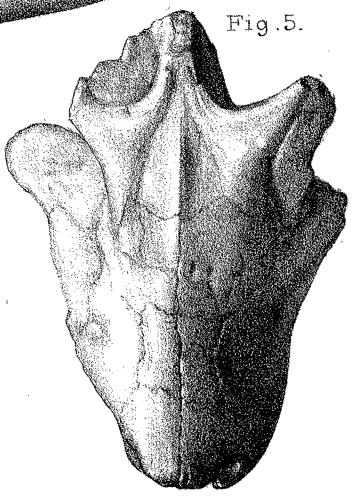

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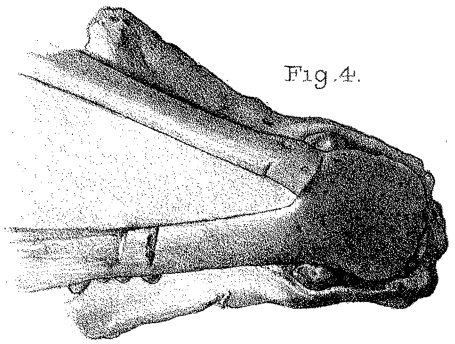

G.M. Woodward del. et lith.

West, Newman imp.

Trirachodon.

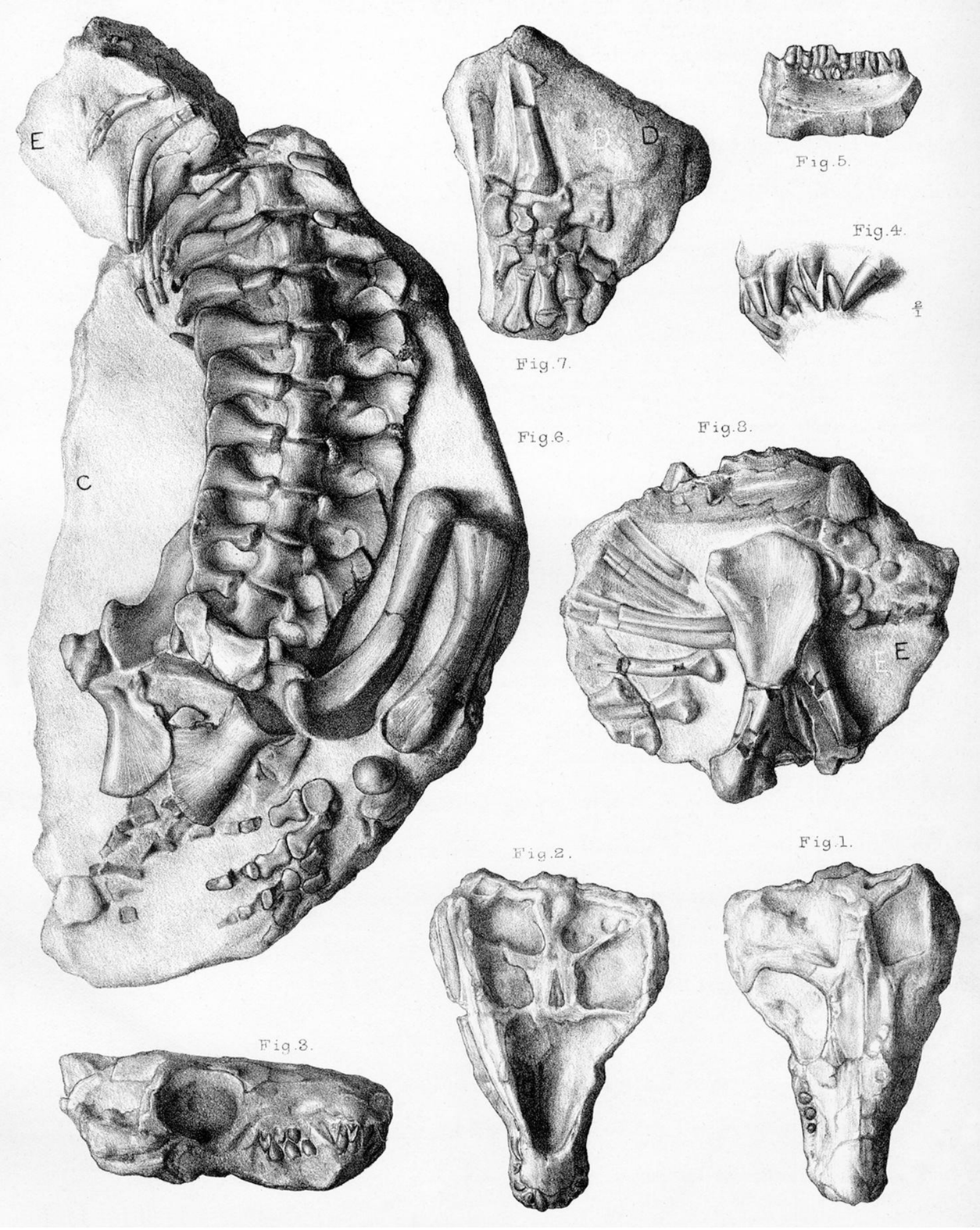

PLATE 1.

Microgomphodon.

Fig. 1. Skull of *Microgomphodon oligocynus*, seen from above, showing the nasal, maxillary, frontal, pre-frontal, and malar regions, with the orbits, and temporal vacuities. It is somewhat distorted. Found by Mr. ALFRED BROWN, near Aliwal North.

Fig. 2. The same skull, seen from the palatal aspect, showing the basi-sphenoid region, pterygoid bones, lower jaw, and posterior palatal vacuities.

Fig. 3. Right side of the same skull, showing the contour of the head, and anterior part of the lower jaw, with the teeth, orbit, &c.

Fig. 4. Left side of the same skull, twice natural size, showing the pre-molar and canine teeth.

There is no evidence that this skull belongs to the same species as the other remains figured on the plate, which were collected by Dr. KANNEMEYER, near Burghersdorp.

Fig. 5. Fragment of skull, showing part of the lower jaw and upper and lower molar teeth. *Microgomphodon eumerus.*

Fig. 6. Thoracic part of skeleton, showing ventral aspect of the hinder part of the vertebral column, the pelvis, and hind limb. The pubic bones are not now in natural contact with the other elements of the pelvis, but are drawn in the position which they are believed to have occupied.

Fig. 7. Bones of the anterior extremity, including parts of the ulna and radius, the carpus and metacarpus, of the same specimen.

Fig. 8. The humerus, scapular arch, and ribs of the same animal.

All the figures on this plate are of natural size, except fig. 4.

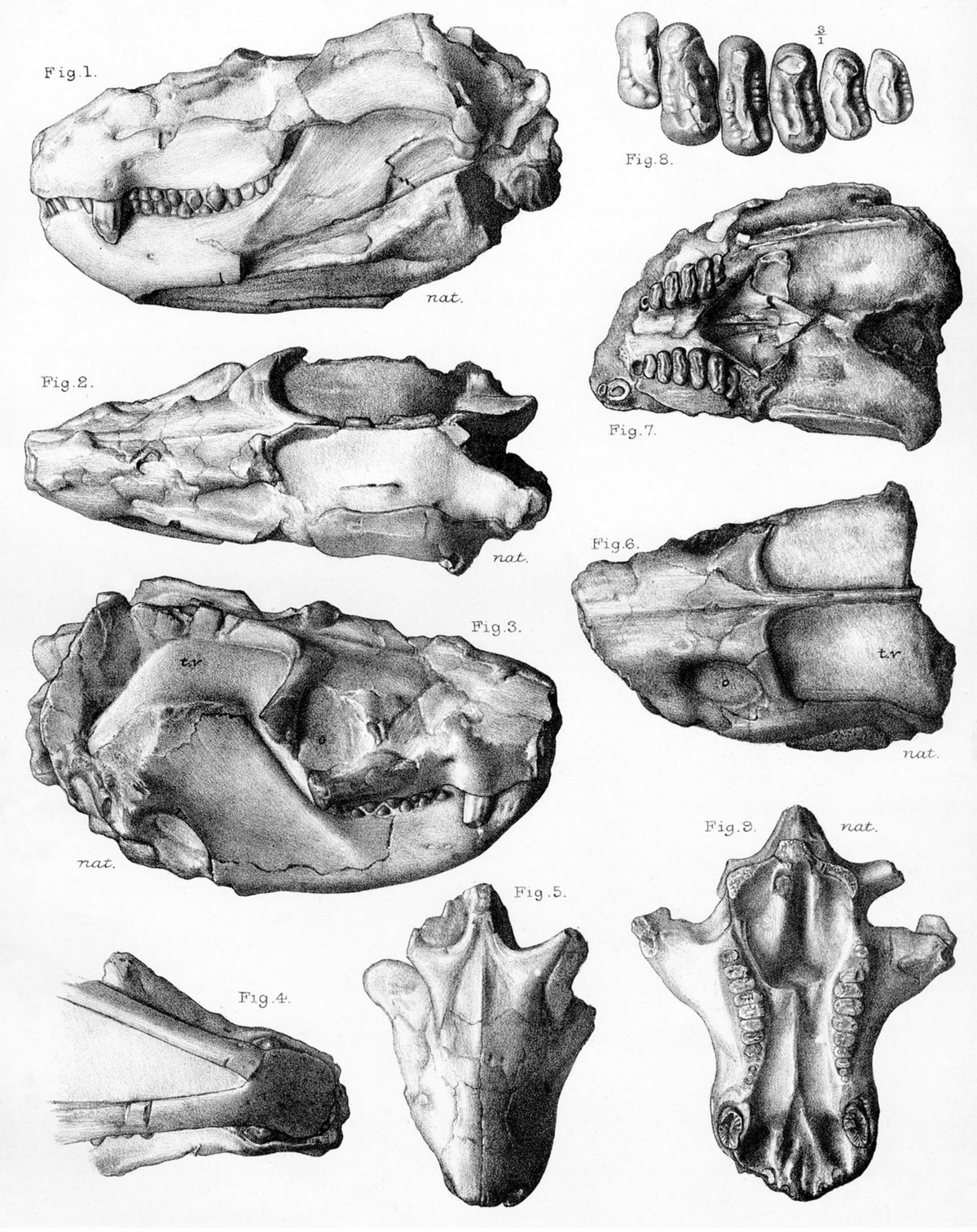

PLATE 2.

Trirachodon Kannemeyeri (figs. 1–8).

All these figures are of natural size, except fig. 8, which is enlarged three times.

Fig. 1. Left side of the skull, showing the lower jaw in contact, with its coronoid process passing beneath the malar arch.

Fig. 2. Same skull, seen from above, showing the elongated temporal vacuities and the posterior notch in the occipital plate.

Fig. 3. Right side of the skull, with the malar arch broken away, showing the coronoid process of the dentary bone of the lower jaw, the parietal crest, orbit, and teeth.

Fig. 4. Inferior aspect of the anterior part of the same skull, showing the symphysial region of the mandible fitting between the canine teeth in the skull.

Fig. 5. Anterior superior aspect of a specimen of the same genus found by Mr. Alfred Brown at Aliwal North, which shows the rounded contour of the pre-orbital region of the skull, as well as the sutures between the cranial bones.

Fig. 6. Superior aspect of another skull from Aliwal North, found by Mr. Alfred Brown, which shows the orbit and greater part of the temporal vacuities. It may be compared with fig. 2.

Fig. 7. Palatal aspect of the same skull, showing the transversely expanded molar teeth, and a part of the vault of the palato-nares.

Fig. 8. The molar teeth of the left side enlarged three times to show the details of the three transverse ridges, and crenulation of the crown.

Trirachodon Berryi.

Fig. 9. Palatal aspect of a skull found by Dr. James Berry, of Queenstown. Its specific difference from the other skulls is shown in the narrower crowns, but the teeth are worn down with use, so that identity of structure with the crowns shown in fig. 8 is only indicated in the hinder teeth.